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Suppl. II.

The parasites of Phyllocnistis labyrinthella Bjerk. and their relation to the population dynamics of the leaf-miner

By Ragnhild Sundby
(From the Zoological Laboratory, University of Oslo)

With 38 figures, 2 plates and 20 tables.

1957

Utgitt med bidrag av
Norges almenvitenskapelige forskningsråd

BERGEN 1957 :: JOHN GRIEGS BOKTRYKKERI A/S

NORSK ENTOMOLOGISK TIDSSKRIFT

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CONTENTS

Introduction

Animal populations always fluctuate. Usually these fluctuations are slight, densities are maintained at a reasonably low level, and the number of animals remains fairly constant. But suddenly an increase may occur, and the population densities reach a level high above the equilibrium state. These fluctuations are reported from all groups of animals, and may be more or less periodic. Generally, small animals are reported to have short periodic fluctuations, while larger animals have a longer-term cycle. Moreover, fluctuations are more extreme in the temperate zones where the number of species is smaller, than in the tropics.

These fluctuations or rather the abundance of animal populations, is of great importance to economic biology as well as to ecology in general. Naturally, animal abundance has attracted considerable interest, and the processes governing the abundance of animal populations have been discussed in numerous works. There have been highly divergent opinions on the regulation mechanism, and from time to time different importance has been attached to different factors. In general, earlier theories tend to explain the «control» on a relatively narrow basis, while later a more comprehensive viewpoint is predominant.

The factors concerning animal populations are frequently grouped in physical and biotic factors. Later the term density-dependent and density-independent factors were introduced (Smith 1935).

The main factors attributed any importance are: climate, predators, parasites, disease and nourishment. Glen (1954) stated that it is difficult to appraise the significance of factors which never act independently in nature. To the author it seems impossible to point to any independent factor in biocoenosis altogether.

To provide a key to the more complex situation in nature, it is desirable to call attention to certain controlled laboratory experiments (Hutchinson 1941).

Under the constant conditions in the laboratory, the different factors which influence the population fluctuations are measured.

The rate at which the development depends on temperature and humidity has been studied for different insect species (e. g. Birch 1953, Burges 1956, Chaudhry 1956 and Howe 1953, 1956). The parasitation frequency is also dependent on the temperature (Burnett 1953) and the inter-relation between host and parasites has been demonstrated by De Bach and Smith (1947), Utida (1955) and others. These experiments show that at the beginning the parasites increase in number, the hosts decrease, but the species exist together. The «steady state» is attained after 2 to 3 generations.

The effect of the microsporidian and virus on the development and mortality of the host and the transmission of these infections have been studied in the laboratory by Clark (1955) and Zimmack (1954).

According to different writers (e. g. Chapman and Whang 1934, MacLagan and Dunn 1934–35) animal populations produce a resistance to their own potential rate of increase when living in a limited area. The fecundity of the female decreases with an increase in the population density (Boyce 1946, MacLagan and Dunn 1934–35, Rich 1956, Stanley 1938). Cannibalism greatly affects the egg mortality, a result of the scarcity of food.

In the field, we find a complex of inter-related factors, and the influence of the different factors is difficult to determine. The main reason for the oscilliations of populations varies. Within certain limits the temperature encourages the population density (Ebeling 1933), the climatic factors influence the outbreak of aphids (Walker 1954), and the cold and moisture during hibernation are also of importance (Maercks 1953). Especially during the oviposition period, the climate is of significance.

Disease affects the population dynamic to a great extent (Bucher 1953, Steinhaus 1954). As a rule, contagious disease does not annihilate an insect species, but this can often be reduced 95 to 99 per cent. The importance of predators has been emphasized by Bruns (1954) and Janvier (1956), but the predators as regulating factor are mentioned in different publications (e. g. Lejeune 1955, Pearson 1953).

The parasites have been attributed great importance where the development of the population dynamic is concerned. Usually these insects act with other factors, and their influence varies like the other factors mentioned. The regulating effect has been discussed by Barnes (1940), Hammond (1954), Lejeune (1955), Varley (1947) and others.

According to the investigations mentioned in the foregoing, no general rule can be set down for the regulation factors. Each species must be appraised separately.

The theories concerning the fluctuations in animal populations, were first raised by Thompson (1939) Schwerdtfeger (1941) and Solomon (1949). Later the theories have been discussed by Andrewartha and Birch (1954), Glen (1954), Lack (1954), Nicholson (1954 b), Thompson (1956) and Solomon (1957). In this publication some of the recently published theories only will be discussed, and only the essential points will be mentioned.

Andrewartha and Birch (1954) write as a summary of their views that the number of animals in natural population may be limited by shortage of resources, by the inavailability of these resources, and by lack of time for the positive rate of increase. At the same time they state that very few of the natural populations become numerous enough to make use of all their stocks of food. Material resources, such as food, are probably the least important, the time for increase probably the most important in nature.

According to Lack (1954), food shortage, predation or disease are the limiting factors for the population density, but these factors are not necessarily alternatives, they may act in combination. He examines the factors which affect the regulation of the animal numbers, but has drawn no general theoretical conclusion.

Nicholson (1954 b) concludes that populations are self-governing systems. The regulation of the density occurs in relation to the populations' own qualities, and those of their environments. «The mechanism of density governance is almost always intraspecific competition either amongst the animals for a critically important requisite, or amongst natural enemies for which the animals concerned are requisites».

The general conclusion in the publication of Thompson (1956) is that populations are not self-governing systems which regulate their own densities and maintain inimical factors only to the limit of tolerance. «If an organism does not multiply without limit this is because it is restricted by its intrinsic specific limitations».

Solomon (1957) concludes that it may be the heterogeneity of environments in space and time that independently bring about natural control, but he cannot see a logical basis for this at present. «On the other hand, there are many examples of natural control by density-dependent processes». Earlier Solomon (1953) has pointed to foodstuff and the physical conditions as being the most important factors of storage pest.

The reported theories show how the different authors have highly different views. They agree with each other on some points, but on others they are of opposite opinion. This shows that at present we really know little about the mechanism of animal fluctuations. We have gained information from examinations of different species, and different orders of animals, but in most cases the investigations comprise only a few factors, and the results do not explain the more complex mechanism of fluctuation. The theories of natural control, published hitherto are hypotheses only, without any full explanation of the fluctuations in animal populations.

Nicholson (1954b) is of the opinion that observations and experiments do not themselves provide answers to our problems. «It is necessary to devote at least as much care and energy to their design and interpretation as to the collection data».

Thompson (1956) states that we cannot deductively obtain a detailed prevision of natural events. «It is on observation and experiment that we must rely to reach a realistic understanding of the changes in population». «If we desire to find principles on which to base our theories of populations, we must look for them in the behaviour of individual organisms.»

For the author of the present paper, further observations and experiments seem necessary. The different elements of nature must be examined separately, and the produced results and theories carefully examined.

A great continuous attack of the leaf-mining moth *Phyllocnistis labyrinthella,* has given rise to the present examination. During the season, sufficient material has been available, but the season has always been too short, unfortunately. The investigation deals with one of the factors, the parasites to which different authors have attributed great importance where the population dynamic is concerned. The field conditions seem to be ideal for a widely applied examination of the problems connected with the abundance of animal populations. The present paper does not solve the riddle of the continuous attack of *Phyllocnistis labyrinthella*, but the author wanted to study the parasites during the present heevy attack with the intention to increase the understanding of the parasites as individual organisms.

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Problems

As mentioned in earlier publication (Sundby 1953) the leaf-mining moth *Phyllocnistis labyrinthella* has occurred frequently in large areas of Norway the past 15–20 years. Before that time, the moth was present (Haanshus 1933) but seldom appeared. The last years, on the other hand, the population has risen to a high level, and small fluctuations only have been observed. The distribution of the moth is shown in figure 33. Within these areas, the devastation of the aspen is clearly visible. From a distance the aspens look like silver poplars, and are plainly distinguished from other hardwood trees. The population of the moth is almost saturated, only a few animals more have the chance to develop on the greatly attacked trees. The food shortage seems to prevent a further increase of population density. Outside the areas with the attacked aspens, *Phyllocnistis labyrinthella* does exist, but the population density is low, only a trace of attack has been observed.

According to Hesselberg and Birkeland (1956) climatic changes have taken place in Norway in the last years. The climate has become warmer, but the rise in the mean temperature in the years 1941–50 is small compared with the annual mean temperature in the preceding decade (1931–40).

The increase in the population of *Phyllocnistis labyrinthella* occurred about 1939–40, accordingly after years with increasing temperatures. It seems natural to connect the sudden rise in population density of *Phyllocnistis labyrinthella* with the change in the climate, and of course, such connection cannot be denied. No examination was carried out before 1950, and nothing is known about the circumstances immediately before and during the first heavy attack.

During the present investigation the moth was found distributed in areas with different temperatures, and no marked differences in climate have been observed near the limits of the pest attack. The data on the temperatures in the different areas are gathered from Norsk meteorologisk årbok, and the tables of the five days mean temperatures. This information is all related to the macro-climate and an examination of the micro-climate in the different territories would be desirable. The circumstances during the experiments have hitherto been insufficient for the mentioned research.

No connection has been found between the geology of the country and the distribution of the moth. In the territories where the geological conditions have been examined, the limits of the pest attack cross the geological boundaries.

The mortality in the first larval stages of *Phyllocnistis labyrinthella* is probably due to different diseases. The daily deathrate in these instars within the greatly attacked territories, has previously been estimated from 1.6 to 4.6 per cent (Sundby 1953). In the territories without any attack, the mortality in the earlier stages of development seems to be smaller than in the areas first mentioned. The microsporidian and the virus were, during the preliminary study of these factors, not found to have a marked different effect in the attacked and unattacked territories.

The predacious insects seem to be of little importance during the present heavy attack. The ant *Formica rufa* L. only is pointed out as predator on the moth. By cutting a slit in the leaf's cuticle, the ant plunders the larvae during the pre-pupal stage. The number of killed larvae is low. The aspens visited by this predator have great populations of aphids, and a larva is rarely taken. In the territories without any attack of *Phyllocnistis* no insect is pointed out as predator on this moth.

This summary shows that nothing is known about the rise of the population size in 1940, and that the regulation factors, above mentioned, namely the climate, the geology, the disease and the predators seem to be of little importance. The only factor which remains is the parasites.

During the present investigation 14 parasitic species have emerged from *Phyllocnistis labyrinthella.* Available literature gives only slight information as to the parasites of the moth. One species only, *Eulophus pectinicornis* is reported to emerge (Jansson 1952). Bjerkander (1790) indicates the presence of parasitic insects, but without any determination of the species. The 14 species are all found to be primary parasites. Two hyperparasitic specimen only of the genus *Anagrus* Hal. are found.

The problems in connection with the continuous heavy attack of *Phyllocnistis labyrinthella* are numerous, and obviously, an explanation of the slight fluctuations are impossible to give on the basis of the examination of one of the «regulating» factors.

Material and methods

The examinations have been carried out partly in the field, and partly in the laboratory. Three different areas were chosen: 1. the territories around Oslo (stations 120–125), 2. Telemark, about 120 km south/southwest of Oslo (stations 1–89), and 3. Trøndelag, about 400 km north of Oslo (stations 101–112) (fig. 33). In addition, material was collected in Råde, 70 km south of Oslo, and around Arendal, 190 km south/southwest of Oslo. In all territories, the aspen grows singly or in groups and mingled with other hardwood or fir trees. Only in Telemark the fir trees may make up the greater part of the woods. In Trøndelag the stations are located between 10 and 100 m; around Oslo about 100 m, and in Telemark between 100 and 250 m above sea level.

To secure the most complete emergence of the parasites, material was collected in July, immediately before the emergence of the moth and parasites. The samples were always taken from different aspens, and from different sides and heights on the trees. Each sample consisted of 3–400 leaves. The collection of the material for the calculation of the proportion between emerged moth and parasites was started after the animals had quitted the leaves. The emergence in the laboratory takes place in bottomless bottles placed on filter-paper (fig. 28). The humidity is controlled by moistening the latter. The bottles were 10 cm in diameter and 15 cm deep, inside measured. The pockets where pupation takes place were cut off, and were placed in the bottles. Thus parasites of other insects living on aspen leaves were prevented from emerging. After the emergence, the parasites creep into test-tubes placed on the opening of the bottles. These tubes were changed every day. The specimen for use in experiments on parasitation were kept alive on honey and water.

According to Morris (1955), the mechanics of collecting the samples require great attention. Many years may pass before the desirable techniques are developed. As to the present methods, controlling samples show that the collecting method used was tolerably representative.

For the oviposition experiments in the laboratory, petri dishes as well as test-tubes of different sizes were employed. Test-tubes 1.6 × 15 cm turned out to be the most convenient for the experiments.

One female was placed in each tube, as a male or more females might cause disturbance. The larvae used in the experiments in the laboratory were collected in the field. The leaves attacked were partly taken to the laboratory before the third larval stage was reached and partly isolated with celluloid-cylinders on the trees before this age of the larva. Either way, contamination of the larvae by parasites before the experiments was avoided. A host of the last larval or prepupal stage with a smaller part of its leaf was placed in the glass tube. The piece of leaf sufficed for the larvae throughout the experiment. Usually only one host was placed in each tube.

The oviposition was carried out at different temperatures, usually between 18 and 24° C. The light seems to have little influence on the oviposition. Although by far the greater number of eggs were deposited earlier during daytime, some were laid as late as 23 o'clock in the evening. During the darkest hour of the night, oviposition never was observed.

To measure the duration of the development, the animals were kept in a thermostate from the egg stage on. The temperature was maintained at 22° C ± 1° C. The humidity was neither controlled nor measured. As the development takes place inside the leaf, the humidity in the mine will keep nearly constant as long as the leaf is fresh. As soon as the eggs of the parasite had been deposited in or at the host larva, the leaf with the latter was transported to a petri dish, which was placed in the thermostate. To prevent the leaf from drying, the bottom of the dish was covered with a slightly moistened filter paper. After the pupation of the parasitic larva, the emergence took place in small glass tubes, 5 × 0.8 cm.

For closer examination of the different stages, the following technique was employed. The morphology of the mandibles was revealed partly by boiling the head in 10 % potassium hydroxide, and partly by squashing the whole unfixed larva. The last method gave the best result. The number of larval stages was difficult to determine. Larvae were fixed at intervals of 6 hours, and the length of the mandibles measured. Alcoholic Bouin and Kahle were used for the fixation of the material, the former being the most satisfactory. As a standard condition for examination, the antennae were kept half an hour in 10 % KOH at 70° C. All the drawings were made by means of a camera lucida.

In the description of the different species, the terms of Essig (1942) are used in part.

The parasites

During the present investigation, 14 species of the family *Chalcididae* were found as parasites on *Phyllocnistis labyrinthella*. The description and the biology of the emerged species follows.

The species

Cirrospilus Westwood.

This genus was described by Westwood in 1832. It has a world-wide distribution with a great number of species. The genus is at present being subjected to revision (Delucchi, personal communication), and some species will probably be transferred to other genera. The author has preferred to use the names of Thomson (1878), and the species of the present investigation has been compared with the specimen of his collection at the Entomological Institution in Lund.

Cirrospilus vittatus Walker.

Cirrospilus vittatus was described by Walker in 1838. The following description of the present material is based on the author's observations:

Female: Yellow, with black-green markings. Head only with four black streaks on pronotum. Eyes usually red, ocelli black. Antennae yellow, scape with black spot at distal part, pedicle and funicle segments black at base, clava sometimes a little darker than funicle. Thorax with a dark medial streak, parapsidal furrows and propodeum black. Legs yellow. Abdomen with black transversal streaks. Ovipositor black. Distribution of black colour varies somewhat.

Antennae short. Pedicle longer than first funicle segment. Funicle segments of about the same length. Clava three segments,

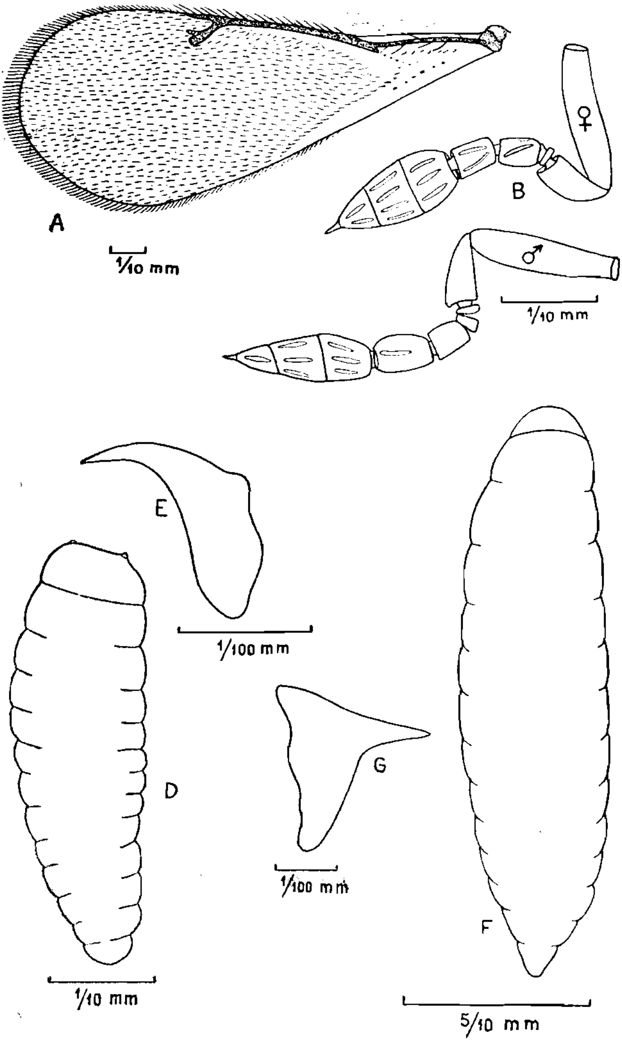

Fig. 1. *Cirrospilus vittatus.*
A: Forewing. B: Antennae. D: The newly hatched larva.
E: The mandible of the first instar. F: The full-grown larva.
G: The mandible of the last instar.

first clava segment longer than the second funicle segment. Number of annelli two (fig. 1 B). Mesoscutum and scutellum punctured. Scutellum broader than long, with two longitudinal streaks. Propodeum weakly punctured, without carina. Stigmal vein longer than postmarginal vein. Marginal vein four times the length of stigmal vein (fig. 1 A). Abdomen oval, of about same length as thorax.

Length: 1.1–1.5 mm.

Male: Colour same as the female, black markings often less pronounced than in the female. Abdomen sometimes almost entirely yellow. First funicle segment shorter than second. Clava a little more elongated. Abdomen shorter than thorax.

Length: 0.9–1.3 mm.

The distribution in the examined territories is shown in figure 34.

Specimens of this species have been determined to the genus *Zagrammosoma* Ashm., but according to Schmiedeknecht (1909), the characteristics of the present species do not agree with those of this genus. Ferrière (1952) has mentioned *Cirrospilus vittatus* as a species not very different from *Zagrammosoma variegatum* Masi, the latter having a somewhat darker colour near the stigmal and marginal veins. He also claims that the funicle segments of *Zagrammosoma variegatum* should be more triangular. The main differences, however, should be the different characteristics of the two genera, e. g. the different numbers of the annelli. Until the revision of the genus *Cirrospilus* is completed, the author wants to use the name *Cirrospilus vittatus.*

Biology.

The development of this species is described by Dowden (1941). During his study, he reared *Cirrospilus vittatus* from the leaf-mining sawfly *Phyllotoma nemorata* Fall., *Phanomeris phyllotomae* and *Scolioneura betulae* Zadd. The present investigator has used as host the *Phyllocnistis labyrinthella.*

Egg: The whitish egg of *Cirrospilus vittatus* is cylindrical in shape, with both ends bluntly rounded, one being a little broader than the other. The length of the egg varied between 0.21 and 0.35 mm, the average was 0.30 mm (15 observations). The size of the eggs laid by a single female varies considerably. The length of 4 eggs were 0.21, 0.24, 0.28 and 0.28 mm.

The egg is placed externally upon the host. Hatching takes place after 39 hours (8 observations, max. 46 hours, min. 32 hours). Shortly before the hatching, the larva is visible through the transparent egg shell, and it is possible to observe how the mandibles move to make a slit in the epidermis. After the escape of the larva, the egg shell is left empty beside the host.

The larva: The larval period lasts about 8 days, and during this time the larva grows from about 0.3 mm to 1.9 mm in length. Its final size may vary a little with the largeness of the host, usually the skin only remains of the latter. Only the largest specimen of the host are not completely sucked out. As it contains more food than necessary for the development, the parasite leaves the host without consuming it. The larva seems to change its skin three times. This agrees with the investigation of Dowden (1941).

As in other hymenopterous species, the larva consists of a head and 13 body segments. In the newly hatched larva (fig. 1 D), the head is broader than the body segments, e. g. the breadth of one head was 0.07 mm, and of prothorax 0.05 mm. During the larval period, the head becomes smaller in proportion to the thorax, and in a fully grown larva the head may be 0.2 mm in breadth, the prothorax 0.3 mm. The larva of the last stage (fig. 1 F) has a more spindlelike shape, the front part becoming more rounded. On the head the diminutive antennae are ranging out.

The alimentary canal is seen through the transparent larval skin. It fills the greater part of the body, and frequently shows rhythmic contractions.

The shape of the mandibles of the first and the last larval stage is seen in figure 1 E, G. In the newly hatched larva, the chitinized part is slightly curved, but later becomes nearly straight. The length of this part during the different stages is 0.006, 0.008, 0.010 and 0.013 mm.

The respiratory system consists of two longitudinal trunks. In the last larval stage there are 9 pairs of spiracles, which are situated in the second and third thoracic segments, and in the abdominal segments 1 to 7. The spiracles of the thoracic segments are slightly bigger than the others. The first had a diameter of 0.015 mm in a fully grown larva, the main abdominal spiracles having a diameter of 0.011 mm. The spiracle in the first abdominal segment was smaller than the others, with a diameter of 0.008 mm. The larva is capable of considerable movement. Immediately after the hatching, the larva starts the feeding action. By means of the mandibles, the larva cuts the host's cuticle, and sucks the emerging juice. As distinct from the habit of other parasitic wasps (e. g. *Eupteromalus nidulans* Thoms. Proper 1931), the larva of *Cirrospilus vittatus* has been observed changing feeding place several times. It attacks the host at different spots, no place seems to be preferred to the other (figs. 31, 32).

The pupa: When the larva is full-grown it leaves the host, and then remains inactive. The mid-gut opens posteriorly, and the waste material accumulated during the larval life is eliminated. This material, which appears nearly black, is set off in small lumps beside the larva, generally two to three on each side. In this way, the full-formed pupa remains surrounded by black excremental pellits. The formation of the pupa commences with a stretching of the thoracic segments, while those of the abdomen are contracted. It now attains the general appearance of a pupa. The exuviae remain fastened to the last abdominal segment, and fix the pupa to the leaf.

The newly formed pupa is white, but after a few hours the skin darkens by a black pigment. It is naked and incapable of movement. The eyes, mouth and thorcic appendages, and the thoracic and abdominal segmentation are fairly well defined. The pupa is approximately 1,5 mm in length. (Of 21 pupae the min. length was 0.7 mm, the max. 2.0 mm). The duration of the pupal stage is on an average of 8½ days (17 observations, max. 11½ days, min. 5½ days). It takes about one day from the defecation until the pupa is fully formed.

The duration of the life cycle: The development of *Cirrospilus vittatus* from the egg to the emergence of the wasp lasts on an average about 18 days (17 observations, max. 20 days, min. 15 days). The whole development takes place inside the leaf, at the place where the host was mining. As pointed out earlier, the pupa is incapable of movement, and the emergence occurs inside the leaf. The wasp therefore gnaws a little round apperture in the leaf, through which it escapes (fig. 30).

Cirrospilus pictus Nees.

This species was described by Nees 1834, under the name *Eulophus*, but was placed in the genus *Cirrospilus* by Walker 1838. The following description of the present material is based on the author's observations.

Female: Body iridescent black-green, sometimes with a slight purple tinge. Cheek and clypeus usually yellow. Sometimes the greater part of head yellow, with only a black ocellar space and a dark hind part. Scape dark with a yellow streak on ventral side. Pedicle and flagellum dark brown. Scape sometimes yellow on distal part, flagellum with yellow ventral part. Mesoscutum with a yellow streak just in front of scutellum. The size of this streak varies slightly. Tegulae yellow. Pronotum sometimes with yellow spots. Legs yellow, first coxa usually yellow, second and third completely or partly dark. First and second tibia and third femur usually with dark spots. Second tibia always with a longi-

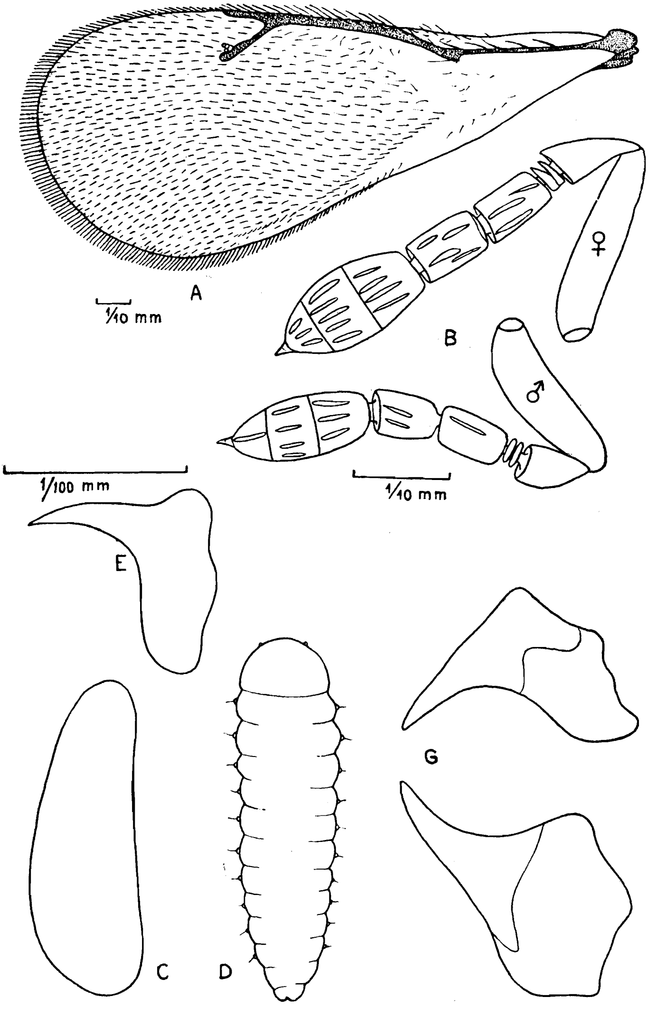

Fig. 2. *Cirrospilus pictus.*
A: Forewing. B: Antennae. C: Egg. D: The newly hatched larva.
E: The mandible of the first larval stage.
G: The mandibles of the last instar.

tudinal dark streak. Tip of tarsus dark. Abdomen usually with lighter spots on lateral parts.

Antennae comparatively short, inserted below middle of face. Pedicle of about same length as first funicle segment. Second funicle segment small, shorter than the first. Clava consisted of three segments, first segment of about the same length as second funicle segment. Number of annelli two (fig. 2 B). Pronotum and mesoscutum hard fastened. Parapsidal furrows complete. Scutellum a little longer than broad, with two longitudinal furrows. Mesoscutum and scutellum slightly punctured. Propodeum with a distinct carina, nearly smooth. Stigmal vein slender, longer than postmarginal vein (fig. 2 A). Marginal vein the double length of the stigmal vein, (14:7). Costal cell with bristles. Abdomen oval, longer than thorax.

Length: 1.6–1.9 mm.

Male: Usually lighter than female. Most of ventral thoracic side yellow, legs yellow, always with a dark spot on second tibia. Abdomen with lighter zone near base and tip. Antennae a little shorter than those of female. Scape broad, pedicle shorter than first funicle segment.

Length: 1.4–1.6 mm.

The distribution in the examined territories is shown in figure 35.

Biology.

The biology of this species is described by Dowden (1941). The hosts in his biological study are *Phyllotoma nemorata* Fall., *Fenusa ulmi* Sund. and *Apanteles euchaetis* Ashm. while the present investigation only deals with *Phyllocnistis labyrinthella*.

Egg: The white egg is sylindrical. Both ends are rounded, the one usually a little broader than the other (fig. 2 C). Sometimes the egg may be a little curved. The length is approximately 0.37 mm (41 observations, max. 0.43 mm, min. 0.30 mm). The same female may lay eggs of different length. The length of 8 eggs laid by a single female ranged from 0.32 to 0.42 mm. The length of 8 eggs from another female varied between 0.34 and 0.41 mm.

The egg is placed externally upon the host. The hatching of the egg occured at 22° C ± 1° C after 35 hours (13 observations, max. 42 hours, min. 28 hours).

The larva: The larval period lasts about 7 days (37 observations, max. 11½ days, min. 5½ days). During this time the larva grows from about 0.4 mm to 2.5 mm in length.

The larva is of the usual ectoparasitic chalcidoid type, but there is some difference in shape between the first and last larval stages. In the first instar, the body segments are supplied with small hairs (fig. 2 D), while the last has a nearly smooth skin. The measurements of the mandibles indicate four larval stages. This agrees with the observations of Dowden (1941). The length of the mandibles measured for the present work seems to be shorter than the estimates given by Dowden. The fact that only the chitinized parts of the mandibles have been measured in the present investigation may explain this discrepancy. The length of the chitinized part during the different larval stages is about 0.005, 0.010, 0.014 and 0.017 mm. The shape of the mandibles is illustrated in figure 2 E, G. In the first instar the form of the chitinized part is slightly curved, later it becomes nearly straight.

The respiratory system is well developed. The larva has 9 pairs of spiracles during the last stage. These are situated in the second and third thoracic segments and in the first to seventh abdominal segments. The spiracle in the first abdominal segment is smaller than the others, and lies out of line with the other spiracles. In the fully grown larva, the thoracic spiracles may have a diameter of 0.017 mm, the abdominal spiracles 0.014 mm, and the smallest spiracle 0.007 mm.

The pupa: The feeding habits and the pupation are exactly the same as reported for *Cirrospilus vittatus*. The first stage of the pupation period begins with a contraction of the larva and proceeds through its extension to the full length of the pupa. The all over shortening of the larva results from stronger contraction of the abdominal segments than the stretching which takes place in the thoracic segments. A larva measured immediately after contraction was 1.58 mm. Three days later the pupa was 1.77 mm. The same process of contraction — extension occurs in all other species discussed in the present work.

The newly formed pupa is white, but turns black after a few hours. Its length is about 1.82 mm (50 observations, max. 2.46 mm, min. 1.09 mm). The duration of the pupal stage averages 7 days (27 observations, max. 10 $^1/_2$ days, min. 4½ days). At 22° C ± 1° C the pupation takes about 2 days. The total development of *Cirrospilus pictus* from the egg to the emergence of the wasp, accordingly lasts an average of 15½ days (27 observations, max. 19 days, min. 13 days).

Cirrospilus elegantissimus Westw.

This species was described by Westwood 1832, and established as the type species of the genus. The specimen studied in the present work may be described as follows:

Female: Green to dark green with iridescent purple cast.

Front of head yellow, ocellar space dark, eyes dark brown. Scape brown with a longitudinal yellow streak, pedicle brown with a lighter distal zone, flagellum brown to yellow. Parapsis yellow or only with a small yellow spot. Legs yellow and darker near base. Abdomen green or with yellow areas on ventral side.

Antenna inserted slightly above level of ventral margins of compound eyes. Pedicle shorter than first funicle segment, the latter longer than second funicle segment. Clava three segmented, first segment shorter than last funicle segment. Number of annelli two (fig. 3 B). Pronotum, mesoscutum and scutellum punctured. Scutellum broader than long, with two longitudinal grooves. Propodeum punctured with distinct carina. Stigmal vein longer than postmarginal vein. Marginal vein about 3 times longer than stigmal vein (fig. 3 A). Abdomen oval, a little longer than thorax.

Length: 1.7–2.1 mm.

Male: Coloured as the female, abdomen with a lighter zone near base. Abdomen egg-shaped, shorter than thorax.

Length: 1.5–1.7 mm.

The distribution in the examined territories is shown in figure 36.

Biology.

Egg: The egg of *Cirrospilus elegantissimus* is cylindrical. It tapers slightly from the anterior to the posterior end, and resembles *Cirrospilus pictus*. The egg averages 0.42 mm in length (10 observations, max. 0.47 mm, min. 0.39 mm). The length of 4 eggs laid by the same female ranged from 0.39 mm to 0.47 mm.

The egg stage lasts about 35 hours (11 observations, max. 39 hours, min. 34 hours). The hatching habit is the same as mentioned previously.

The larva: The duration of the larval period, is about 7 days (5 observations, max. 9½ days, min. 5½ days). The newly hatched larva has a length of about 0.4 mm, while the fully grown larva reaches a length of 2 mm. The head of the larva is comparatively broadest at hatching.

The larval body has nearly the same appearance as that described for *Cirrospilus pictus*. Here also the larva of the first stage is equipped with small hairs (fig. 3 D), while the skin of the full-grown larva is almost smooth.

The shape of the mandibles in the first larval stage is slightly curved, while it later on becomes nearly straight (fig. 3 E, G). The measurements of the length indicate four instars and the length of the chitinized part at the different changes of skin are about 0.008, 0.011, 0.014 and 0.017 mm.

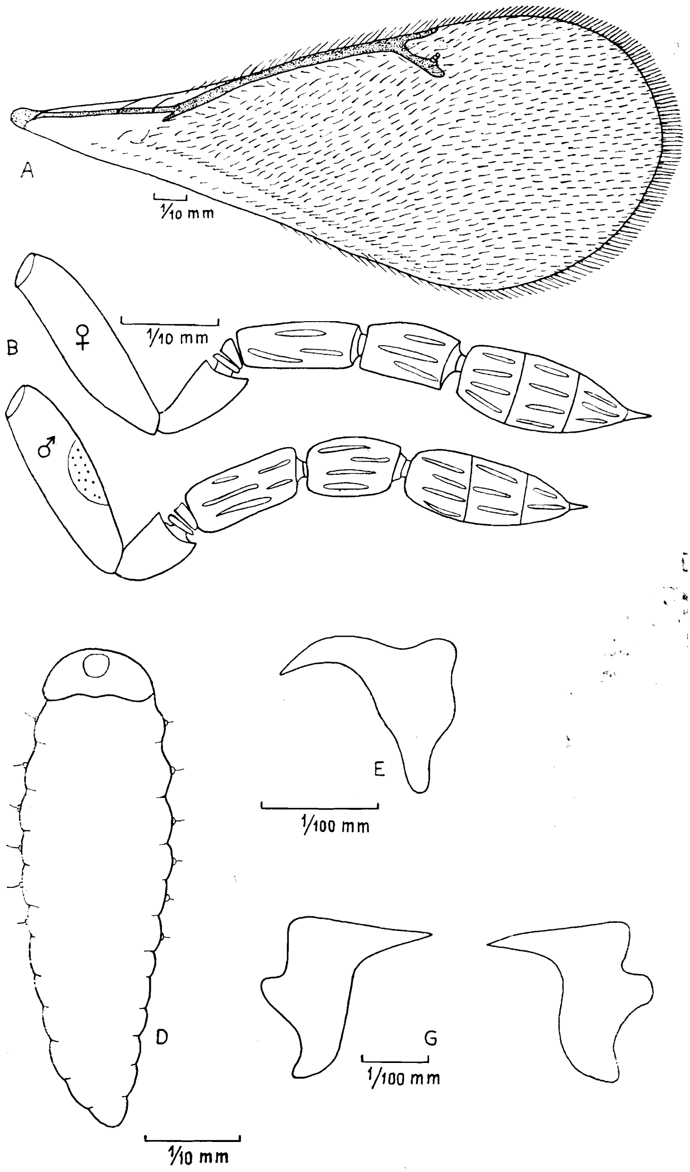

Fig. 3. *Cirrospilus elegantissimus.*
A: Forewing. B: Antennae. D: The newly hatched larva.
E: The mandible of the first instar. G: The mandibles of the last instar.

The last larval stage has 9 pairs of spiracles, i. e. in the second and third thoracic segments, and in the abdominal segments 1 to 7. The relative position of the spiracles is as mentioned previously. In the fully grown larva, the thoracic spiracles are about equal in size and with a diameter of about 0.017 mm. The smallest abdominal spiracle is close to 0.008 mm, the even-sized abdominal spiracles of about 0.014 mm.

The pupa: The behaviour of the larva and the pupation conform to that of *Cirrospilus pictus*. When first formed the pupa is white, later on it darkens heavily. The length is about 1.66 mm (6 observations, max. 1.99 mm, min. 1.34 mm). The pupal period lasts on an average 7 days (8 observations, max. 8½ days, min. 4½ days). The pupation takes about two days. The whole development of *Cirrospilus elegantissimus* from the egg to the emergence of the wasp, thus requires on an average 15 days (8 observations, max. 17 days, min. 13 days).

Cirrospilus subviolaceus Thomson.

This species is described by Thomson 1878. The specimens emerged during the present work have the following morphology:

Female: Black and yellow. Black colour with iridescent green cast. Head yellow with black spots on back side. Eyes brown, ocelli red. Scape yellow with dark spot on distal part, pedicle and flagellum brown. Pronotum black, other parts of thorax yellow with exception of frontal part of mesoscutum, distal part of scutellum, metanotum and propodeum. Mesosternum black. Mesoscutum and scutellum with a broad yellow band. Legs yellow. Abdomen light brown with dark dorsal side.

Antennae inserted near middle of face. Pedicle shorter than first funicle segment, the latter longer than second segment. Clava three segments, first segment shorter than second funicle segment. Number of annelli two (fig. 4 B). Mesoscutum and scutellum slightly reticulated. Scutellum as broad as long with two longitudinal streaks. Propodeum smooth, with a distinct carina. Marginal vein two to three times as long as stigmal vein. Stigmal vein shorter than postmarginal vein (fig. 4 A). Abdomen oval, distal part protruding, longer than thorax.

Length: 1.9 – 2.1 mm.

Male: Same colour as female, but dark pigment more abundant. Distal part of mesoscutum, front part of scutellum and tegulae yellow. Propectus, episternum and epimeron yellow, other part of thorax black. Parapsis with a little dark spot. Base of abdomen yellow. Abdomen egg-shaped. Abdomen and thorax of equal length.

Length: 1.3 mm.

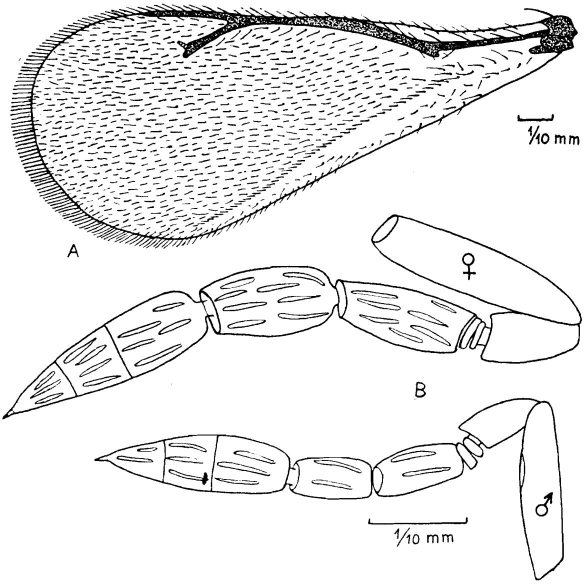

Fig. 4. *Cirrospilus subviolaceus*. A: Forewing. B: Antennae.

The distribution in the examined territories is shown in figure 37.

The three species *Cirrospilus pictus*, *Cirrospilus elegantissimus* and *Cirrospilus subviolaceus* may at first sight seem to be the same species, only with different extention of the drawings. The main colour of the body is however distinctly different. *Cirrospilus pictus* convey the impression of being black, *Cirrospilus elegantissimus* dark green and *Cirrospilus subviolaceus* dark brown. As to the antennae, those of *Cirrospilus pictus* are shorter than those of the others, and the two funicle segments are nearly equal in length. The antennae of the two other species are nearly equal in length, but the veins of the wings are more prominent. *Cirrospilus elegantissimus* has a short postmarginal vein, while the length of the marginal vein compared to the stigmal vein is greater in *Cirrospilus elegantissimus* (figs. 2, 3, 4).

Biology.

Egg: The egg has essentially the same shape as the eggs of the other species of *Cirrospilus*. The length is approximately 0.46 mm (5 observations, max. 0.49 mm, min. 0.43 mm). These eggs were laid by the same female.

The hatching of the egg occured after about 40 hours (5 observations, max. 46 hours, min. 36 hours.)

The larva: The larval period lasts approximately 7 days (one observation only). The larva grows from about 0.4 mm to 1.8 mm in length during this time. The shape of the larva is very near that found for the other species of *Cirrospilus*. During its first stage this larva also has some small hair-like appendages on the different segments.

The mandible has nearly the same appearance as that described of *Cirrospilus pictus*. The way the mandibles varies in size indicates four instars. The medium size of the chitinized part during the different stages is 0.007, 0.012, 0.014 and 0.017 mm. In the first larval stage, the mandibles look like plain curved hooks, but later they straighten out.

The respiratory system is like that of the previously mentioned species, and 9 pairs of spiracles are present in the last instar. These are situated in the second and third thoracic segments, and the abdominal segments one to seven. The size is the same as in *Cirrospilus pictus*.

The pupa: The newly formed pupa is white, but turns black after a few hours. The length is about 1.75 mm (one observation only), and the pupal stage lasts nearly 7½ days. The duration of the whole development of *Cirrospilus subviolaceus* has been 16 days for the only specimen raised to the imago in the laboratory.

For the observations of the development of *Cirrospilus subviolaceus*, only the offspring of a single female was available. She was caught in 1953, and in that year, no facilities for constant temperature were available. Later on the species has not been found for observations on development.

Eulophus Geoffroy

This genus was described by Geoffroy 1762. The type species was *Ichneumon ramicornis*. It is a genus with a great numbers of species.

Eulophus pectinicornis L.

Eulophus pectinicornis was described by Linné 1858. The specimens of the present material may be described as follows:

Female: Head and thorax dark green to black, with a red-green iridescent cast. Abdomen brown to yellow. Antennae dark, with exception of yellow scape. Legs yellow brown with darker parts.

Antennae inserted below middle of face, pedicle short, first funicle segment longer than segments two and three, which are of roughly the same size. Clava two segments. Number of annelli one (fig. 5 B). Pronotum proportionally large, narrower than thorax. Mesoscutum and scutellum punctured, scutellum tighter than the rest. Propodeum with a distinct carina and costulae, the latter reaching carina near the middle. Propodeum smooth. Marginal vein three times as long as stigmal vein (30:10). Postmarginal vein long. Abdomen oval, equal in length to thorax.

Length: 1.7–2.1 mm.

Male: Colour same as female. Scape dark, abdomen with a lighter spot near base. Funicle segments one to three with branches (fig. 5 B). These segments short, fourth segment and clava enlarged. Abdomen shorter than thorax.

Length: 1.6 mm.

The distribution in the examined territories is shown in figure 38.

Biology.

Egg: The egg is white, of an oblong shape, somewhat larger at one end than at the other (fig. 5 C). Its length is approximately 0.44 mm (23 observations, max. 0.49 mm, min. 0.37 mm). There is a considerable variation in the size of the eggs laid by a single female. The length of 5 eggs measured, varied from 0.38 to 0.49 mm, the variation of 8 eggs laid by another female was from 0.41 to 0.49 mm. The length of the eggs vary irrespective of the size of the females. The egg is placed externally on the host. The duration of the egg period is about 39 hours (9 observations, max. 45 hours, min. 36 hours). The emergence occurs as described for the species of *Cirrospilus.*

The larva: The larval period lasts about 8½ days (25 observations, max. 12½ days, min. 5½ days). During this period the length of the larva increases from about 0.5 mm to 2.6 mm.

At every stage the larva has a hymenopteriform shape (Clausen 1940), and consists of head and 13 body segments. In the newly hatched larva (fig. 5 D), the head is broader than the body segments. During the larval period, the head becomes smaller in proportion to the thorax (fig. 5 F).

The measurements of the length of the mandibles indicates 4 or 5 instars. The chitinized part at the newly hatched and fully grown larva is about 0.010 and 0.022 mm. The shape of the mandibles in these stages is shown in figure 5 E, G. In the first instar the form of the chitinized part is slightly curved, later it becomes nearly straight.

The respiratory system is well developed. The larva has 9

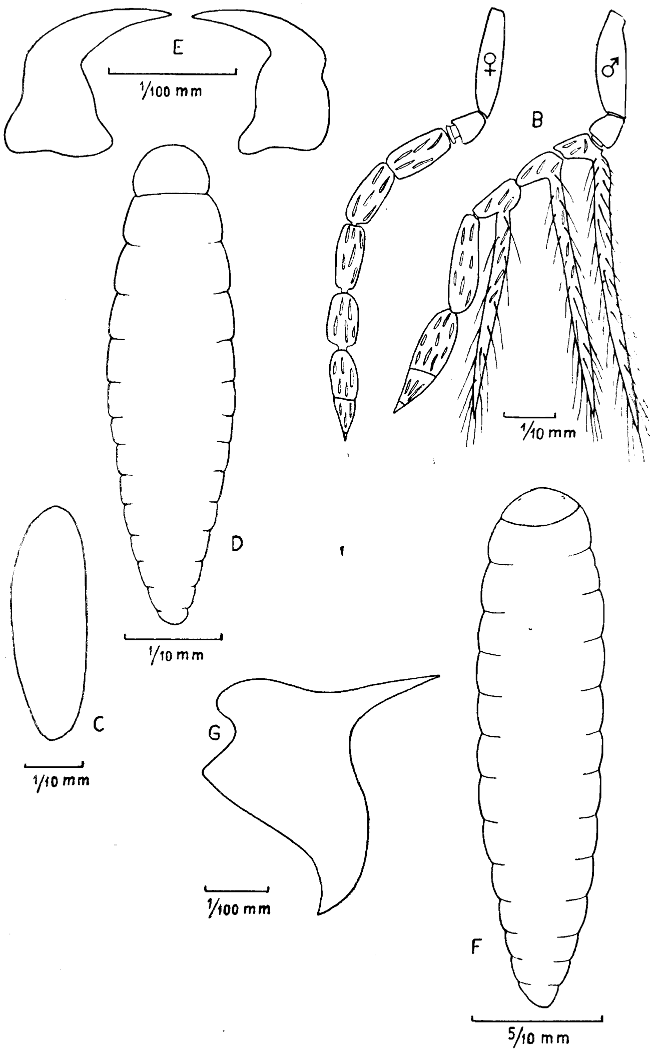

Fig. 5. *Eulophus pectinicornis*.
B: Antennae. C: Egg. D: The newly hatched larva.
E: The mandibles of the first instar. F: The full-grown larva.
G: The mandible of the last instar.

pairs of spiracles during the last stage. These are situated in the three thoracic segments, and the abdominal segments 1 to 6. The spiracles in the third thoracic segment lay closer to the median plane than the other. The thoracic spiracles are about equal in size and with a diameter of 0.02 mm, the abdominal spiracles 0.017 mm.

The pupa: The feeding habits and the pupation are similar to those described for *Cirrospilus vittatus*. The pupation period begins with a contraction of the larva and proceeds through its extention to the full length of the pupa. A larva measured immediately after contraction was 2.18 mm. One day later the pupa was 2.29 mm. Another specimen was measured at 1.88 and 2.2 mm in length for the corresponding stages.

The newly formed pupa is white, but turns black after a few hours. The length is about 2.15 mm (26 observations, max. 2.70 mm, min. 1.42 mm). The duration of the pupal stage averaged 7 days (4 observations max. 10 days, min. 6 days). The pupation takes about 1 day. Some of the pupae hibernate, and the emergence does not occur until next spring. The progenies from a single female behave differently. In 1954 one pupa only of 11 developed from eggs from the same female hibernated (tab. 9), the others emerged the same year. The oviposition occurred in June, and the hibernated pupa originated from egg number 10. *Phyllocnistis labyrinthella* was the host for the female as well as for the offspring. All the pupae developed from oviposition in July and August hibernated. This was the case whether the egg was placed on the larva of *Phyllocnistis labyrinthella* or *Lyonetia clerckella*. The total development for the specimens which did not hibernate, constitutes 17 days (max. 20 days, min. 13 days, 4 observations).

Eulophus longulus Zett.

This species was described by Zetterstedt 1838. The specimen studied in the present work may be described as follows:

Female: Colour green to blue, abdomen sometimes with a brown tinge. Antennae dark, scape metallic green. Coxae most frequently dark, nearly whole, or at least proximal half of femur, distal part of tibia and tip of tarsus dark, other parts yellow-brown.

Antennae inserted below middle of face, pedicle short, funicle segments one to two of about same length, longer than third segments. Clava two-segmented, number of annelli one (fig. 6 B). Anterior part of thorax narrower than the rest. Mesoscutum and scutellum heavily punctured. Propodeum smooth with a distinct

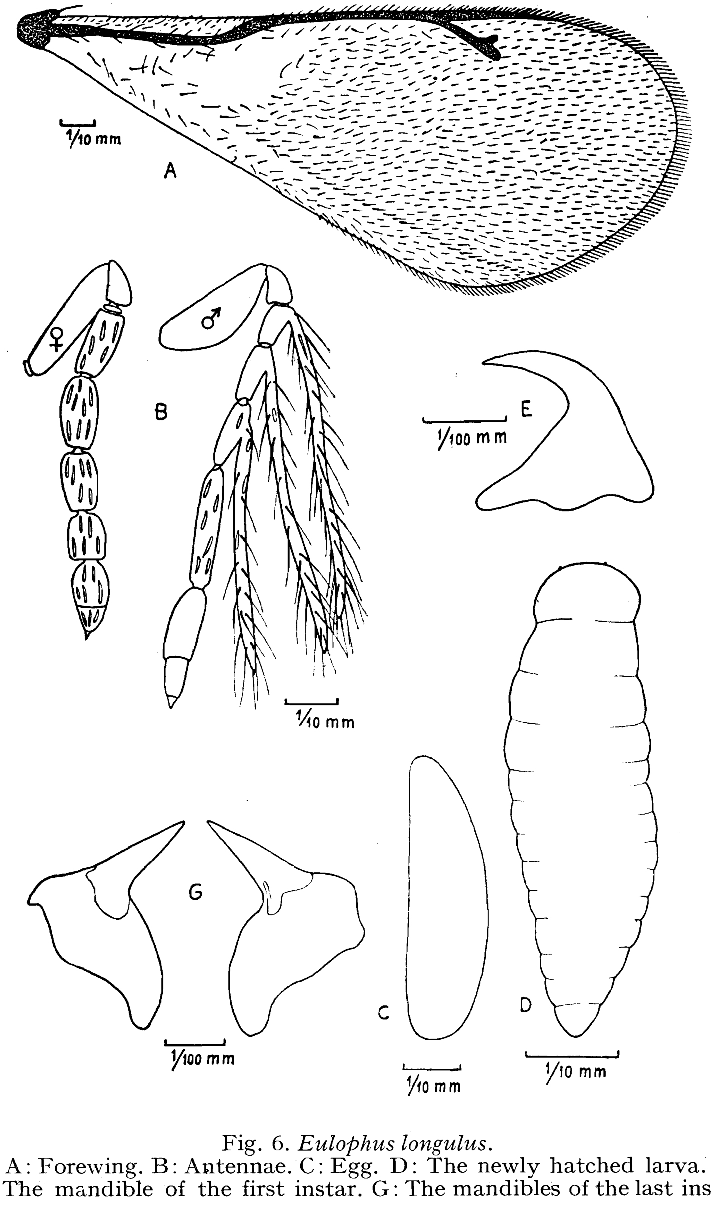

Fig. 6. *Eulophus longulus.*
A: Forewing. B: Antennae. C: Egg. D: The newly hatched larva.
E: The mandible of the first instar. G: The mandibles of the last instar.

carina and costulae, the latter reaching carina before middle of length. Marginal vein approximately three times longer than stigmal vein (35:11) (fig. 6 A). Abdomen oval, longer than thorax, but shorter than head and thorax together.

Length: 2.1–2.3 mm.

Male: Colour practically the same as in the female. Sometimes with a more reddish cast especially on scutellum. Abdomen with a lighter zone near base. Funicle segments one to three with branches, fourth funicle segment and clava enlarged. Abdomen as long as thorax.

Length: 1.8–2.0 mm.

The distribution in the examined territories is shown in figure 39.

Biology.

Egg: The egg has essentially the same shape as that of *Eulophus pectinicornis* (fig. 6 C). The length varies between 0.51 mm and 0.42 mm (17 observations, average 0.46 mm). The length of 3 eggs, laid by one female developed on *Phyllocnistis labyrinthella* as the host, varied from 0.41–0.49 mm.

The hatching of the egg occurred at 22° C ± 1° C after about 39 hours (3 observations, max. 44 hours, min. 32 hours). Hatching habit as previously mentioned.

The larva: The duration of the larval stage is about 7 days (24 observations, max. 9½ days, min. 5½ days). During this time the larva grows from about 0.5 mm to 2.6 mm in length.

The morphology of the larva (fig. 6 D) is similar to that of *Eulophus pectinicornis*. The shape of the mandibles in the newly hatched and full-grown larva is shown in figure 6 E, G. The chitinized part in these two stages is about 0.013 mm, and 0.02 mm in length.

The respiratory system consists of two longitudinal trunks. The larva has 9 pairs of spiracles during the last stage. These are situated in the three thoracic segments and in the abdominal segments from one to six. The spiracles in the third thoracic segment lie out of line with the other spiracles and slightly more dorsally. In the fully grown larva, the thoracic spiracles may have a diameter of 0.019 mm, the abdominal spiracles 0.015 mm.

The pupa: The length of the black pupa is about 2.33 mm (15 observations, max. 2.86 mm, min. 1.66 mm). No emergence occurred the same year. All the pupae, developed from eggs deposited in June to August hibernate, and emerge in May the next spring. This was the case with the specimens developed on *Phyllocnistis labyrinthella* as well on *Lyonetia clerckella*, and where the host of the females were *Phyllocnistis labyrinthella* or *Lyonetia*. The development of *Eulophus longulus* from the egg to the pupa is on an average 9½ days (20 observations, max. 11 days, min. 9 days). The rest of the pupae may last 11 month.

Eulophus straminiepes Thoms.

This species was described by Thomson 1878. The following description of the present material is based on the author's observations.

Female: Head and thorax green, abdomen green to brown, sometimes with a lighter zone on ventral side. Scape light, other part of antennae brown, legs yellow-white. Second and third coxae sometimes with smaller or greater coloured parts.

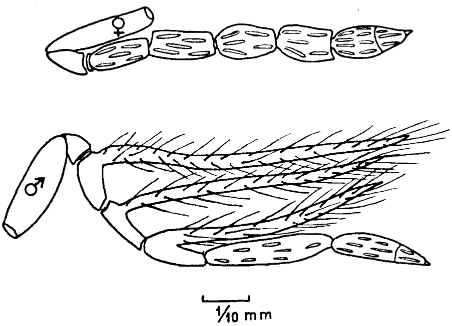

Fig. 7. The antennae of *Eulophus straminiepes*.

Antennae inserted below middle of face. Pedicle short, funicle segments one to three of about same size, clava two-segmented, number of annelli one (fig. 7). Pronotum proportionally large. Anterior part of thorax narrow. Mesoscutum and scutellum punctured, but not to the same extent as in *Eulophus pectinicornis*. Propodeum nearly smooth with carina, but without costulae. Marginal vein about three times the length of stigmal vein (26:10). Postmarginal vein long. Abdomen lancet shaped, longer than head and thorax together.

Length: 2.3–2.4 mm.

Male: Colour more iridescent red to violet purple. Scape dark, abdomen with a large lighter zone. Funicle segments one to three with branches. Fourth funicle segment and clava enlarged (fig. 7). Abdomen equal in length to thorax.

Length: 1.9 mm.

The distribution in the examined territories is shown in figure 40.

All oviposition attempts of this species have failed. The females have attacked the host, but no eggs were deposited.

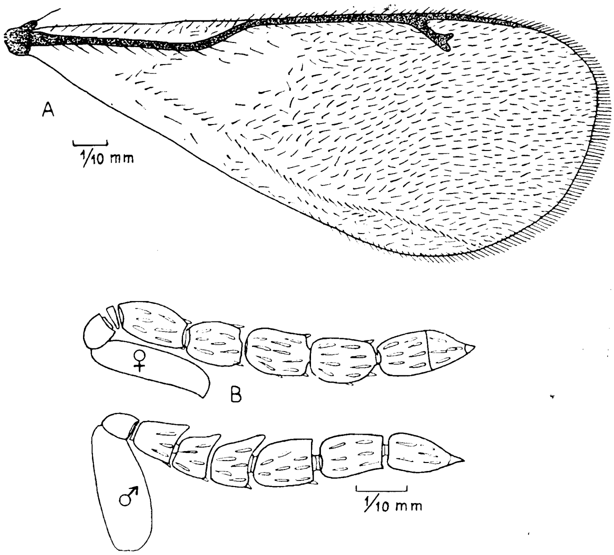

Fig. 8. *Sympiesis sericeicornis.*
A: Forewing. B: Antennae.

Sympiesis Førster

This genus was described by Førster 1856 with *Eulophus sericeicornis* as the type species. It is a genus with few species.

Sympiesis sericeicornis Nees

This species was described by Nees 1834, under the name *Eulophus sericeicornis*. The specimen emerged during the present work have the following morphology:

Female: Body blue to green. Antennae and legs dark, basis of tibia and tarsus light brown.

Antennae long, inserted below middle of face. Pedicle short, first funicle segment longer than the other, segments number two to four of about same length. Clava consisting of two segments. Number of annelli one (fig. 8 B). Pronotum proportionally large, anterior part a little narrower, anterior part of mesothorax narrow. Mesoscutum and scutellum heavily punctured, scutellum almost as broad as long. Propodeum nearly smooth, with a distinct carina. Postmarginal vein more than three times as long as stigmal vein (36:7) (fig. 8 A). Abdomen lancet shaped, longer than thorax, distal part tapers somewhat.

Length: 2.3–2.5 mm.

Male: Colour more green than in female, with a copper-red cast. Antennae without branches with lighter zone on border. Funicle segments one to three drawn out in upper edge. These three segments of about same length. Clava consists of two separated segments. (fig. 8 B). Abdomen shorter than thorax, with a lighter zone near base.

Length: 1.7 mm.

The distribution in the examined territories is shown in figure 41.

This species may easily be confused with the species of *Eulophus*. The most distinct caracteristics are the different length of the veins of the wings (figs. 6 and 8).

It has been impossible to get this species ovipositing in the laboratory. The biology of *Sympiesis sp.* is described by Dowden (1941). However, the pictures indicate that the species he studied belonged to the genus *Eulophus.*

Epilampsis Del.

As to the genus *Epilampsis,* this was described by Delucchi 1954 (a). During a revision of the *Chrysocharis-Derostenus* species, this group was divided in four genera instead of two. *Epilampsis* is characterized by the collar of the pronotum and the third annelli where the first funicle segment has a slanting wedge, and are always solidly fastened. The abdomen of the male is without any lightened dot.

Epilampsis tadici Del.

This species was described by Delucchi 1954 (b). The specimen studied in the present work may be described as follows:

Female: Colour green to coppery. Head above facial line green to blue, face copper-sheen. Antennae dark. Scape with exception of distal part white. Tegulae yellow. Coxae and tip of tarsus dark, other part of legs white.

Antennae inserted beneath middle of face. Pedicle of about same size as third funicle segment. Clava consisting of two segments. Number of annelli three (fig. 9 B). Pronotum small, thorax with collar. Mesoscutum and scutellum slightly punctured, scutellum nearly as broad as long. Propodeum almost smooth. Postmarginal vein longer than stigmal vein. Angle between these veins greater than 45° (nearly 60°). Abdomen longer than thorax (30:23).

Length: 1.1–1.9 mm.

Male: Colour more red than is the case with female, legs

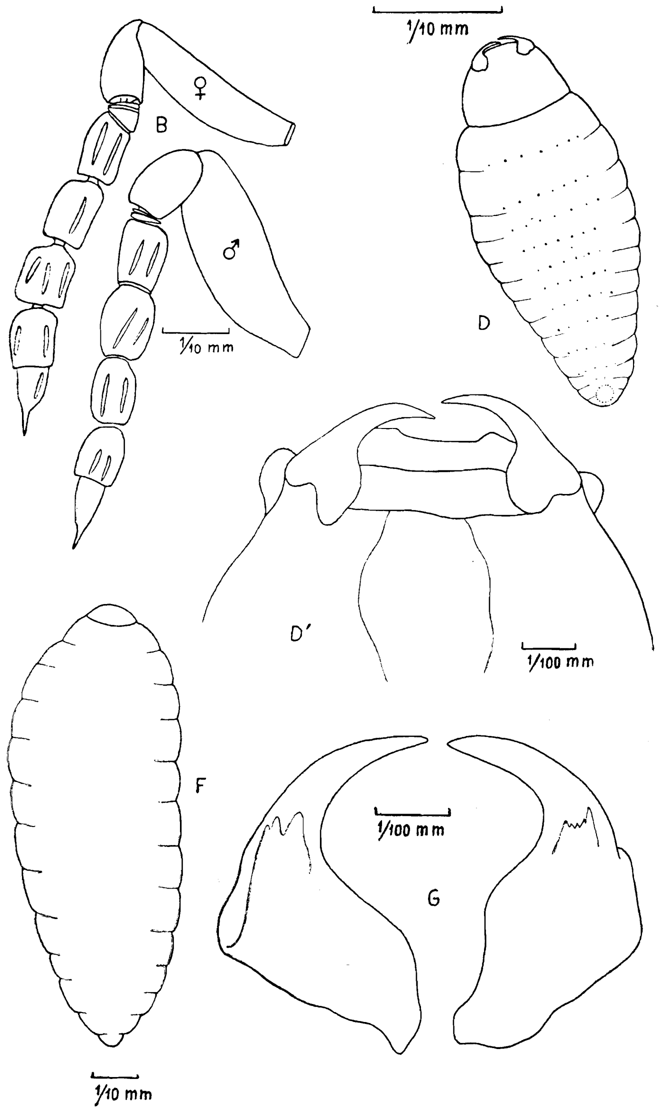

Fig. 9. *Epilampsis tadici.*
B: Antennae. D: The newly hatched larva.
D': Front part of the same larva. F: The full-grown larva.
G: The mandibles of the last larval stage.

more yellow. Scape nearly brown, broader than that of female. Abdomen a little shorter than thorax.

Length: 1.3–1.6 mm.

The distribution in the examined territories is shown in figure 42.

Biology.

Egg: The eggs of the entoparasitic species are like those of the ectoparasites, cylindrical in shape with both ends rounded, acutely tapering toward one end. The length is approximately 0.3 mm (11 observations, max. 0.38 mm, min. 0.26 mm), and of milky colour. The same female may lay eggs of a length varying from 0.33 to 0.38 mm. The egg is placed inside the host skin.

The hatching of the egg occurs after a time of about 40 hours (6 observations, max. 42 hours, min. 39 hours).

The larva: The larval stages occupy a period of about 8 days (34 observations, max. 12½ days, min. 7½ days). The increasing of the larva's length during this time is about 0.3 mm to 2 mm.

The larva consists of a head and 10 clearly defined body segments. The difference in shape between the first and later larval stages is more pronounced than that observed in the ectoparasitic species. In the entoparasitic larvae, the head is longer in proportion to the other segments, and the mandibles are more visible (fig. 9 D, D′). The later larval stages are more similar in shape to the ectoparasitic larvae (fig. 9 F). In the first instar, the body segments are supplied with a row of small chitinized hooks. On the last abdominal segment these hooks are greater and form a chaplet (fig. 9 D).

It has been impossible to determine the number of the ecdysis.

The shape of the mandibles in the first and last larval stage is illustrated in figure 9 D′ and G. The length of the chitinized part of the newly hatched larva is about 0.024 mm (a length of 0.030 mm has been measured), of the fully grown larva 0.027 mm (a length of 0.045 mm has been measured). The length of the mandibles is as seen nearly the same during the whole larval life, the shape, however, is somewhat different. In the first larval stage, the mandibles look like slender hooks, with mainly the farthest part curved. Later the mandibles get thicker, with the bending more uniform.

The respiratory system is well developed. The last larval stage has 7 pairs of spiracles, i. e. in the second thoracic segment and the abdominal segments two to seven. In this instar the thoracic spiracles are about equal in size and with a diameter of 0.014 mm, the abdominal spiracles are close to 0.011 mm.

The pupa: The mature parasitic larva occupies the whole body cavity of the host, i. e. the host pupal covering case encloses the parasite completely. The pupation commences with the bursting of the covering case, and the formation of the pupa occurs in the same way reported for the ectoparasitic species. The newly formed pupa is white, but after a few hours the skin darkens by a black pigment. The length is about 1.85 mm (14 observations, max. length 2.26 mm, min. length 1.42 mm). The pupal period lasts on an average 7 days (10 observations, max. 8½ days, min. 3½ days). It takes about one day from the defecation until the pupa is fully formed. The duration of the total development of *Epilampsis tadici* from the egg to the emergence, is on an average 17 days (10 observations, max. 19 days, min. 14 days). The development is carried through whether the host attains the pupal stage or not. Distinct from other parasitic species (Flanders 1944), the developmental period is independent of the host condition.

Epilampsis gunholdi Del.

This species was described by Delucchi 1954. The species emerged during the present work have the following morphology:

Female: Head green with a weak copper-sheen, and a more bluish colour above facial line. Eyes dark brown to reddish. Scape white to light brown, with exception of brown distal part. Pedicle and flagellum brown. Thorax green with a light copper colour, ventral side dark green to brown. Tegula yellowish to light brown. Coxae metallic green, second, third and sometimes the first femur brown, other parts of legs white. Intensity and distribution of coloured part of femur vary somewhat with different specimen. Tip of tarsus brown. Abdomen green with copper-sheen.

Antennae inserted beneath middle of face. Pedicle of about same size as first funicle segment, the latter of same length or shorter than third funicle segment. Second segment usually longer than others. Last segment only a little longer than broad. First clava segment shorter than third funicle segment. Third annelli large (fig. 10 B). Scutellum of about same length as breadth. Mesoscutum and scutellum reticulated. Reticulation of mesoscutum stronger than that of scutellum. Propodeum nearly smooth without carina. Angle between marginal and stigmal vein 50–60°. Submarginal vein with two greater and six to eight smaller hairs. Petiolus short. Abdomen oval, somewhat longer than thorax.

Length: 1.5–1.7 mm.

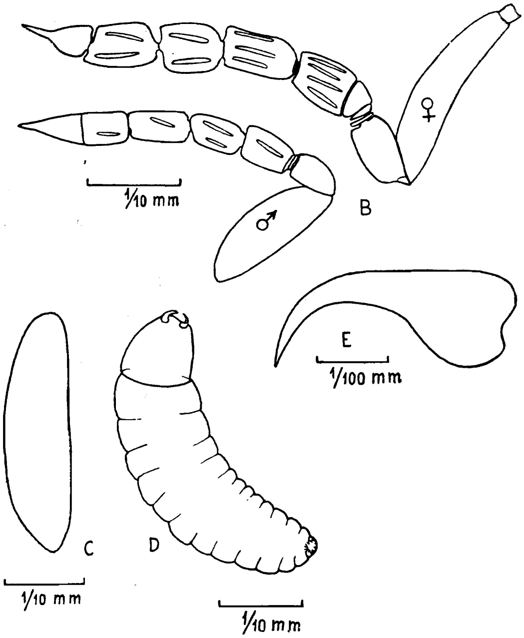

Fig. 10. *Epilampsis gunholdi.*
B: Antennae. C: Egg. D: The newly hatched larva. E: The mandible of the first instar.

Male: Vertex of nearly same colour as other part of head. Thorax with more red colour than in the case of the female. Scape light brown, legs more yellow, greater or smaller parts of femur dark coloured. Abdomen shorter than thorax.

Length: 1.0–1.4 mm.

The distribution in the examined territories is shown in figure 43.

As to the antenna, the proportion between the length of the different segments may vary. One might think these antennae belonged to different species, but no other distinct difference in features was observed. Similar conditions are reported for other species (Rosen 1956).

Biology.

Egg: The egg has essentially the same shape as that of *Epilampsis tadici* (fig. 10 C). The length is approximately 0.30 mm (6 observations, max. 0.31 mm, min. 0.29 mm).

The egg is placed inside the host skin.

The hatching takes place after a time of 40 hours (3 observations, max. 42 hours, min. 39 hours).

The larva: The larval period lasts about 11 days (max. 12½ days, min. 10½ days). During this time the larva grows from about 0.28 mm to 2 mm in length. The larval body (fig. 10 D), has nearly the same appearance as that of *Epilampsis tadici*. The shape of the mandibles in the first larval stage is shown in figure 10 E. The length of the chitinized part in a newly hatched larva is 0.024 mm, in the fully grown larva, i. e. a larva of 1.9 mm in length, 0.027 mm.

The respiratory system is well developed. The last larval stage has 7 pairs of spiracles. These are situated in the second thoracic segment and the abdominal segments two to seven. In the fully grown larva the thoracic spiracle may have a diameter of 0.009 mm, the abdominal spiracles 0.008 mm.

The pupa: When first formed the pupa is white, later on it darkens considerably. The length is about 1.89 mm (3 observations, max. 2.07 mm, min. 1.72 mm). The pupal period lasts about 7 days (one observation). The pupation takes about one day. The whole development of *Epilampsis gunholdi* from the egg to the emergence of the wasp takes nearly 18 days (one observation).

Epilampsis boops Thoms.

This species was described by Thomson 1878 as *Chrysocharis boops*, but was transferred to *Epilampsis* 1954 (Delucchi). The following description is based on the author's observations.

Female: Green to blue, with iridescent red cast. Head above facial line blue to green, face coppery. Scape white, with exception of black distal part. Tegulae yellow. Pedicle and flagellum brown. Legs white, coxa, proximal part of third femur and tip of tarsi black.

Antennae inserted beneath middle of face. Pedicle of about same length as first and third funicle segments. Second funicle longer than first, and third. Clava of two segments. Number of annelli three (fig. 11). Scutellum of about same length as breadth, with strong reticulation, some flattened. Reticulation of mesoscutum stronger than that of scutellum. Propodeum smoother, with a weak carina. Angle between stigmal and postmarginal vein nearly 50°. Petiolus short. Abdomen egg-shaped, shorter than thorax.

Length 1.5 mm.

After the revision of the genus, this species belongs to the colouredlegs group of *Epilampsis*. According to the collection of Thomson this is not correct, but owing to the difference between the short-abdomen specimens in the present material,

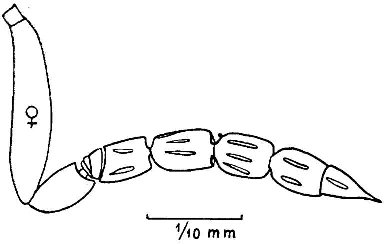

Fig. 11. The antenna of *Epilampsis boops*.

they are divided into the species *Epilampsis boops* and *Epilampsis mirabilis*.

This species was only emerged from *Rhynchaenus populi* Fbr. During the laboratory investigations it was tried only in the host changing experiments. The duration of the developing stages is not measured.

Epilampsis mirabilis n.sp.

Female: Head green to copper. Vertex green to blue. Cheek somewhat darker than other parts of head. Eyes dark brown to red. Scape white with a brown touch near distal end. Pedicle and flagellum brown. Thorax green, mesoscutum and scutellum sometimes with blue reflex. Tegula yellow-white. Ventral side of thorax dark green to brown. Legs white, coxae and tip of tarsi brown.

Antennae inserted beneath middle of face. Pedicle shorter than first funicle segment. Funicle segment of about same length. Third annelli with triangular shape, and a length near a third of first funicle segment (fig. 12). Scutellum longer than broad, with a strong reticulation, convex. Propodeum nearly smooth with a weak carina. Angle between stigmal and postmarginal vein nearly 50°. Costal cell of fore-wings hairless. Submarginal vein with two greater and four to six smaller hairs. Petiolus short. Abdomen egg-shaped, length almost double the breadth (20:11), shorter than thorax.

Length: 1.3–1.4 mm.

Male: Vertex of nearly same colour as other part of head, lighter blue than case with female. Scape nearly brown, with only a lighter streak. Scape broader than that of the female, in accordance with the other males of the genus, and more hairy. Abdomen nearly the same length as thorax.

Length: 1.0–1.1 mm.

Type: In the author's collection.

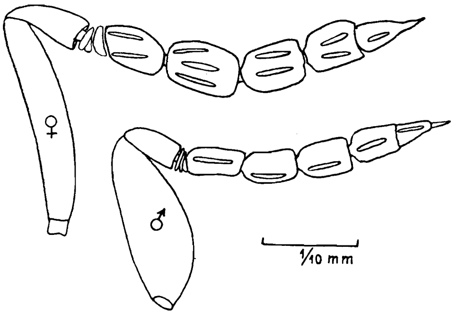

Fig. 12. The antennae of *Epilampsis mirabilis*.

The distribution in the examined territories is shown in figure 44. The species has not been found for observations on development.

This species is classified as belonging to the group of the genus *Epilampsis* which has white legs. The most closely related species is *Epilampsis deciduac* and *Epilampsis tadici*. *Epilampsis mirabilis* has the reticulation of the scutellum similar to *Epilampsis deciduae*, but the length and the breadth of scutellum is nearly equal as opposed to that of *Epilampsis deciduae*. The angle between the postmarginal and stigmal vein is greater (50°) and the pedicle has virtually the same length as first funicle segment. As to *Epilampsis tadici* the antennae are nearly the same as that of *Epilampsis mirabilis*, but the former has a greater angle between stigmal and postmarginal vein (60°) than that of the new species. The scutellum at *Epilampsis tadici* is less reticulated, compared to *Epilampsis mirabilis*, and the colour more coppery. The abdomen of *Epilampsis mirabilis* is some shorter than thorax, that of *Epilampsis tadici* longer. *Epilampsis mirabilis* is similar to *Epilampsis boops*, but the legs are white.

Closterocerus Westw.

This genus was described by Westwood 1833. It is a genus with a worldwide distribution.

Closterocerus trifasciatus Westw.

This species was described by Westwood 1833 as the type species of the genus. The specimen studied in the present work may be described as follows:

Female: Body blue, mesoscutum and scutellum iridescent blue-green, antennae and legs dark, pro- and mesotibia and tarsus yellow. Wings with three dark stripes (fig. 13 A).

Antennae short, inserted below middle of face. Funicle segments broader than long. Second clava segment acutely painted. Number of annelli one (fig. 13 B). Collar distinct. Scutellum nearly as broad as long. Mesoscutum and scutellum heavy, propodeum weakly punctured. Postmarginal vein shorter than stigmal vein, both of small size compared with marginal vein. Abdomen egg-shaped, shorter than thorax.

Length: 0.8–1.3 mm.

Male: A more green-red iridescent colour on mesoscutum and scutellum. Abdomen of a more triangular shape.

Length: 0.8–1.1 mm.

The distribution in the examined territories is shown in figure 45.

Biology.

Egg: The egg is nearly straight, with both ends rounded, and acutely tapered toward one end. The length is approximately 0.25 mm (4 observations, max. 0.30 mm, min. 0.23 mm). The egg is deposited in the body of the host larva.

The egg stage lasts about 38 hours (4 observations, max. 40 hours, min. 36 hours).

The larva: The approximate duration of the larval period is 9 days (one observation). During this time the larva grows from about 0.36 mm to 1.6 mm in length.

The larva looks like, and has the same feeding habit as observed in *Epilampsis* (fig. 13 D, F). As in the latter, small hooks are situated on the last abdominal segment (fig. 13 D).

The shape of the mandibles of the first and last larval stage is shown in figure 13 E and G. The length of the chitinized part in a newly hatched larva is 0.025 mm, in a fully grown larva 0.024 mm. The measurements show the mandibles in these two instars to be nearly equal in length, while the shape differs considerably. In the first larval stage the mandibles have a slender and fairly curved shape, later on they remain curved, but thicken. The number of the instars has not been determined with certainty.

The respiratory system is well developed, and the full-grown larva has 7 pairs of spiracles. They are situated in the second thoracic segment, and the abdomen segments two to seven. The thoracic spiracle may have a diameter of 0.011 mm, the abdominal spiracle 0.008 mm.

The pupa: When first formed the pupa is almost white, later on darkening to black. The length is about 1.50 mm (one

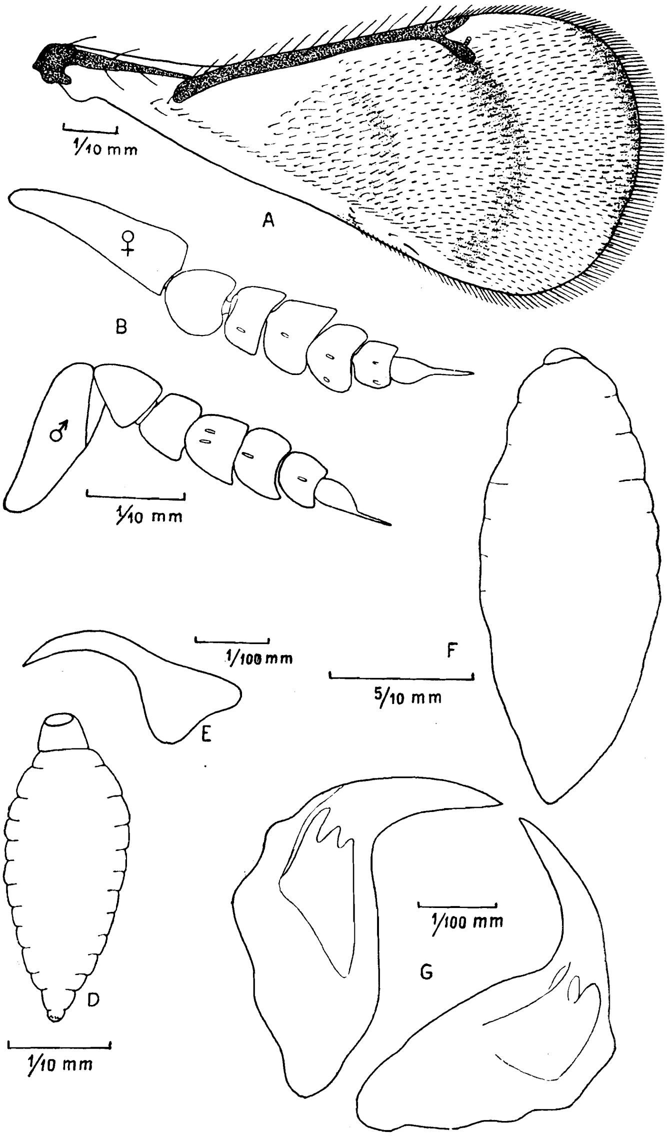

Fig. 13. *Closterocerus trifasciatus.*
A: Forewing. B: Antennae. D: The newly hatched larva.
E: The mandible of the first instar. F: The full-grown larva.
G: The mandibles of the last instar.

observation). The pupal stage lasts about 9 days (one observation). The duration of the development of *Closterocerus trifasciatus* from the egg to the emergence of the imago, is on an average 20 days (3 observations, max. 22 days, min. 19 days).

Tetrastichus Walker

This genus was described by Walker 1842 with *Cirrospilus lycidas* as the type species. In 1843 Haliday described the same genus. It is a genus with an enormous number of species.

Tetrastichus xanthops Ratz.

The present species was originally described as *Eulophus xanthops* by Ratzeburg 1844. It was transferred to the genus *Tetrastichus* by Thomson 1878. The specimen of the present material may be described as follows:

Female: Body green with a blue cast. Head green with greater and smaller yellow parts. Clypeus always yellow, ocellar space metallic green. Extention of yellow colour varies. Antennae yellow-brown, tegulae yellow, legs white, basis of third coxa dark, abdomen more or less yellow near base.

Antennae relatively long, inserted beneath middle of face. Funicle of three segments. Pedicle short, funicle segments nearly equal in length. Clava consisting of three segments. Number of annelli one (fig. 14 B). Mesoscutum and scutellum nearly smooth, only weakly punctured. Scutellum of rectangular shape, broader than long, heavy convex with two longitudinal dorsal grooves. Propodeum nearly smooth, without carina, distal part incised. Postmarginal vein only indicated. Stigmal vein four times as long as marginal vein (fig. 14 A). Abdomen oval, to egg-shaped, of same length as thorax.

Length: 0.9–1.2 mm.

In the present material females only are detected.

The distribution in the examined territories is shown in figure 46.

This species is similar to the species *Tetrastichus cyclogaster* to the point of confusion. Ferrière (1952) mentioned the latter as a species related to *Tetrastichus xanthops*, the differences consist in the more yellow colour, the shorter abdomen and the more slender wings at *Tetrastichus cyclogaster*. Thomson (1878) divides the species of the genus *Tetrastichus* in two different sections. *Tetrastichus cyclogaster* belongs to the group with only one bristle on the submarginal vein, *Tetrastichus xanthops* on the other hand exhibits a number of two to five. The proportion between the marginal and stigmal vein is at *Tetrastichus cyclogaster* two to one, at *Tetrastichus xanthops* the same proportion is, according to Burks (1943), five to one.

The species of the present material has a submarginal vein with 3 to 4 bristles, and a length of the marginal vein which is three to four times that of stigmal vein. The abdomen is of equal length to thorax. The species *Tetrastichus cyclogaster* should have a shorter abdomen than *Tetrastichus xanthops*. This seems to indicate that the present species belong to *Tetrastichus xanthops*.

Biology.

The biology of this species is described by Dowden (1941). The hosts in this biological study are *Fenusa ulmi*, *Phanomeris phyllotomae* and *Chrysocharis sp.* while the present investigation only deals with *Phyllocnistis labyrinthella*.

Egg: The egg is of an oblong shape. Both ends are bluntly rounded, the one usually a little broader than the other (fig. 14 C). The length is approximately 0.32 mm (22 observations, max. 0.35 mm, min. 0.25 mm). The size of 17 eggs laid by a single female varied from 0.27 mm to 0.35 mm.

The egg is placed externally upon the host.

The hatching of the egg occurred after 42 hours (5 observations, max. 46 hours, min. 38 hours).

The larva: The larva completes the feeding during about 8 days (13 observations, max. 11 days, min. 6 days). In the course of this time, the larva increases from about 0.33 mm to 1.8 mm in length.

The larval body has nearly the same appearance as that of the other ectoparasitic species. In the first instar the larva has a well defined head and 13 body segments. The head is weakly chitinized and the cuticle supplied with hairs of different length (fig. 14 D). The three thoracic segments and the abdominal segments 2, 4, 6 and 8 have a well-developed intersegmental protuberance, each with a long hair. These hairs measured 0.05 mm in length. These protuberances and hairs are apparently of a considerable aid in locomotion, and the larvae of *Tetrastichus xanthops* move rapidly in contrast to the other ectoparasitic larvae previously mentioned in the present work. In the full-grown larva the protuberance are still prominent, but appear relatively shorter. The hairs are only small spines (fig. 14 F), and the ability of movements less.

The shape of the mandible in the first and last larval stage is shown in figure 14 E, G. The chitinized part increases during the larval period from about 0.005 to 0.020 mm in length. In the first larval stage the chitinized part of the mandibles is curved, later it turns nearly straight.

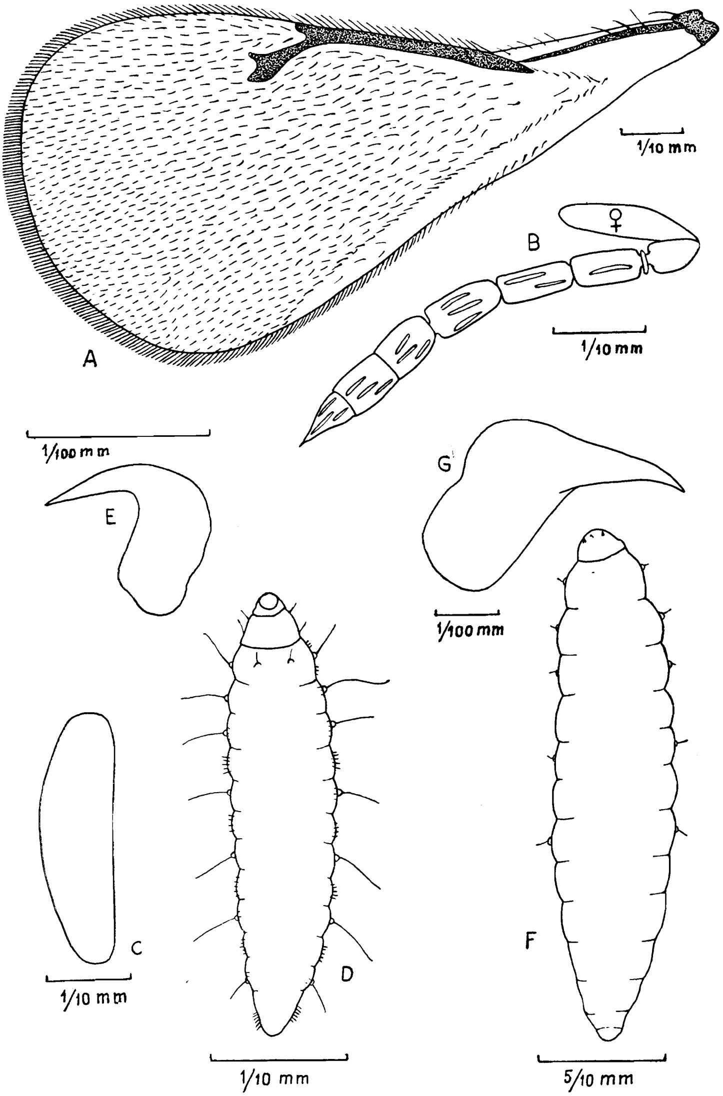

Fig. 14. *Tetrastichus xanthops*.
A: Forewing. B: Antenna. C: Egg. D: The newly hatched larva. E: The mandible of the first instar. F: The full-grown larva. G: The mandible of the last instar.

The respiratory system is like that in the previously mentioned species. In the last larval stage 8 pairs of spiracles are visible, situated in the second and third thoracic segments and the abdominal segments two to seven. The thoracic spiracles may have a diameter of 0.015 mm, the abdominal spiracles 0.012 mm.

The pupa: The pupation conforms to that of the other parasitic species. The newly formed pupa is white, but unlike the other species it later turns light green. The different organs are visible through the pupal covering case. The length of the pupa is about 1.54 mm (6 observations, max. 1.77 mm, min. 1.34 mm). The duration of the pupal stage is on an average 10 days (max. 12 days, min. 7 days, 4 observations). The pupation takes about one day. The total development of *Tetrastichus xanthops* from the oviposition to the emergence of the wasp, accordingly lasts an average of 17 days (5 observations, max. 20 days, min. 15 days).

Tetrastichus femoralis n.sp.

Female: Black to brown, clypeus light to dark brown, eyes brown to grey. Scape dark, other parts of antennae brown to yellow. Tegulae yellow, legs yellow, coxa, proximal part of femur and tip of tarsus brown. Intensity and distribution of coloured parts vary.

Antennae inserted just below middle of face. Pedicle shorter than funicle segments. First funicle segment a little longer than second and third. Third funicle segment a little broader than the other. Clava three segmented.

Number of annelli three, all small size (fig. 15 B). Eyes proportionally small. Pronotum broad, reaching up to the base of parapsidal grooves. Mesoscutum and scutellum nearly smooth, mesoscutum with a weak medial groove. Scutellum nearly oval in shape, broader than long, heavy convex, with two longitudinal dorsal grooves. Propodeum nearly smooth, short with a weak carina. Petiolus very short. Postmarginal vein only indicated. Stigmal vein slender. Marginal vein three times and a half the length of stigmal vein. Submarginal vein with four bristles. Abdomen oval, acutely pointed, twice as long as thorax.

Length: 1.5–1.8 mm.

Male: Colour same as female, clypeus a little darker. Scape broad. Pedicle of about same size as first funicle segment. Funicle segment two to four elongated, increasing in length, the three clava segments elongated. Number of annelli two. Funicle and clava segments with long hairs (fig. 15 B). Abdomen a little shorter than thorax.

Length: 1.2–1.4 mm.

Type: In the author's collection.

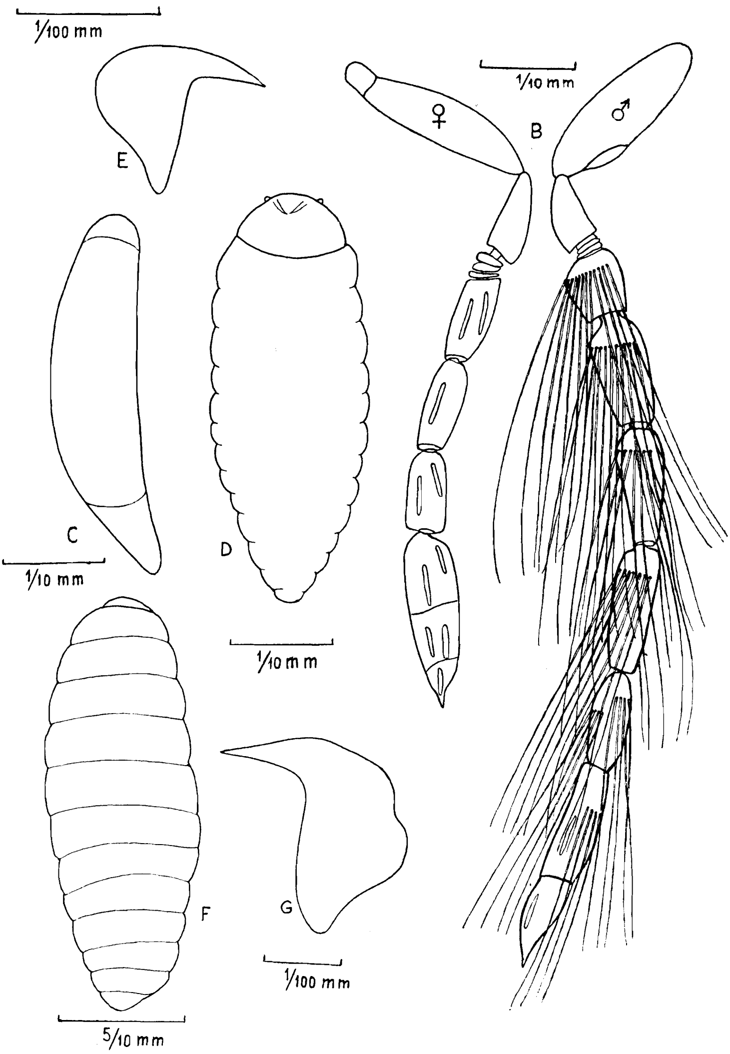

Fig. 15. *Tetrastichus femoralis.*
B: Antennae. C: Egg. D: The newly hatched larva. E: The mandible of the first instar. F: The full-grown larva. G: The mandible of the last instar.

The distribution in the examined territories is shown in figure 47.

Biology.

Egg: The egg of *Tetrastichus femoralis* has a curved shape, narrowing at one end (fig. 15 C). The length is approximately 0.43 mm (12 observations, max. 0.48 mm, min. 0.38 mm). The length of 8 eggs deposited by a single female varied between 0.38 to 0.48 mm. The egg is placed externally upon the host.

The egg period lasts about 43 hours (6 observations, max. 2 days, min. 40 hours). The hatching habit as described previously.

The larva: The larval period is carried through within 8 days (12 observations, max. 10 days, min. 6 days). The increasing of the larva's length during this time is approximately from 0.4 mm to 1.7 mm (♂).

The larval body has nearly the same appearance as that found in other ectoparasitic species (fig. 15 D, F). The number of larval instars are undetermined.

The shape of the mandibles in the newly hatched and full-grown larva is shown in figure 15 E and G. In the first larval stage the mandibles look like small hooks, later they become straighter. The length of the chitinized part increases during the larval period from about 0.006 mm to 0.014 mm.

The respiratory system is similar to that described above. In the last larval stage there are 9 pairs of spiracles, which are situated in the thoracic segments two to three, and the abdominal segments one to seven. The thoracic spiracle may have a diameter of 0.014 mm, the abdominal spiracle 0.012 mm.

The pupa: The feeding habits and the pupation are the same as reported for the other ectoparasitic species. The newly formed pupa is white, but turns black after a few hours. During the laboratory experiments, males only have been developed. There is a great difference in size between the female and the male in this species, and the same probably applies to the pupae. The male pupa is somewhat curved, and the length about 1.27 mm (4 observations, max. 1.66 mm, min. 0.95 mm). The pupal stage occupies on an average 7 days (5 observations, max. 9 days, min. 6 days). At 22° C ± 1° C the pupation lasts about one day. The whole development of *Tetrastichus femoralis* from the egg to the emergence of the wasp is completed in about 17 days (5 observations, max. 18 days, min. 15 days).

The generations

In the laboratory, the examined wasps produce two generations a year. The newly emerged females oviposit from July to August, and the second generation develops in the course of two to three weeks. The progeny issue during the months August and September, with the exception of the species of the genus *Eulophus* only. No emergence is attained the same season of the species *Eulophus longulus*. The progenies, which originates from oviposition in June or July, develop into pupae only. This is the case whether the host is *Phyllocnistis labyrinthella* or *Lyonetia clerckella*. When raised on *Phyllocnistis labyrinthella*, the pupae of *Eulophus pectinicornis* usually issue the same season, while the same pupae developed on *Lyonetia clerckella* always hibernate.

The field material makes it clear that one generation only is developed on *Phyllocnistis labyrinthella* during a season. All the parasitic pupae irrespective of the parasiting wasp, (including the species of *Eulophus*), emerge in July. Eggs are deposited in or at the very few second generation larvae of *Phyllocnistis labyrinthella* accessible. The progeny which succeed to pupate, issue the same year, but most frequently the host is parasitized too early to suffice for the full development of the parasite, and thus preventing pupation.

Only a few of the parasites which developed on *Lyonetia clerckella* in Trøndelag emerged the same year, and no trace of any second generation was observed neither of the host nor the parasites during the years 1954, 1955 and 1956. In the southern part of the country, i. e. south of Oslo, *Lyonetia clerckella* and the parasitic wasp have two generations in a single season, according to this study.

An earlier investigation (Dowden 1941) indicates that the genus *Eulophus* probably has only a partial second generation a year, while the species *Cirrospilus pictus* and *Cirrospilus vittatus* have two. This agrees with the present observations.

Hibernation

The parasitic *Hymenoptera* are reported to winter at any stage of development. *Eulophus* hibernates as a pupa, while the species of *Cirrospilus, Epilampsis* and *Tetrastichus* is supposed to spend the winter as a full-grown larva (Dowden 1941, Johnston 1915, Urbahns 1917).

As to the present investigation it has unfortunately been impossible to follow from one year to another year the wasps parasiting on *Phyllocnistis*. No hibernation was disclosed in the leaves of the aspen. A few pupae were observed in leaves in the autumn, but material collected the next spring, showed no emergence of parasites. Wasps living on *Lyonetia clerckella* issued from the leaves the next spring. The genus *Eulophus* is always found as pupae in the autumn, while the other species were observed partly as pupae, partly as full-grown larvae. Whether the pupation of the latter occure in the autumn or early the next spring was not observed.

Some of the imagines which emerged in July, will be alive as late as the first days of October. (They are fed on honey and water all the time). None of the specimen succeeded to hibernate.

This shows that the different species may hibernate as pupae or full-grown larvae.

The host of the different parasites

The parasites mentioned, have earlier been found on different hosts. In the following list the details refer to the publications of Thompson (1943–50) and Dowden (1941). Informations received from other publications are stated in parenthesis. In Norway the species are reared from *Phyllocnistis labyrinthella* Bjerk., *Phyllocnistis suffusella* Zell., *Lyonetia clerckella* L. and *Rhynchaenus populi* Fbr. Other species were not inspected. The hosts pointed out in the present investigation are marked with * where the host is referred to in earlier publications to, a + and a * are added to the name.

Cirrospilus vittatus:

+*Lyonetia clerckella L.
Orchestes fagi L.
Coleophora laricella Hb.
Phyllotoma nemorata Fall.
Scolioneura betulae Zadd.
Phanomeris phyllotomae Mues.
Fenusa ulmi Sund.
*Phyllocnistis labyrinthella Bjerk.
*Phyllocnistis suffusella Zell.
*Rhynchaenus populi Fbr.

Cirrospilus pictus:

Rhynchaenus alni L.
Coleophora fuscidinella Zett.
Coleophora laricella Hb.
+*Lyonetia clerckella L.
Nematus salicis L.
Aulax rhoeades Gir.
Heterarthrus nemoratus Fall.
Fenusa pusilla Klug.

Fenusa ulmi Sund.
Phyllotoma nemorata Fall.
Apanteles eushaetis Ashm.
Rogas unicolor Wesm.
Stilpnotia salicis L.
Scolioneura betulae Zadd.
*Phyllocnistis labyrinthella Bjerk.
*Phyllocnistis suffusella Zell.
*Rhynchaenus populi Fbr.

Cirrospilus elegantissimus:

*Phyllocnistis labyrinthella Bjerk.

Cirrospilus subviolaceus:

*Phyllocnistis labyrinthella Bjerk.

Eulophus pectinicornis:

Dacus oleae Gmel.
Rhynchaenus fagi L.
Barathra brassicae L.
Polia oleracea L.
Phytomyza plantagines R.–D.
Agriomyza spiraeae Kalt.
Dyseriocrania fasterosella Z.
Nepticula oxyacanthella Stt.
+*Phyllocnistis labyrinthella Bjerk. (Janson 1952).
*Lyonetia clerckella L.

Eulophus longulus:

Rhynchaenus fagi L.
Dacus oleae Gmel.
+*Lyonetia clerckella L.
Oecophyllembins neglectus Selv.
*Phyllocnistis labyrinthella Bjerk.

Eulophus straminiepes:

+*Lyonetia clerckella L.
*Phyllocnistis labyrinthella Bjerk.

Sympiesis seriseicornis:

Lyonetia clerckella L.
Lithocolletis ulmifoliella Hbn.

Cameraria tristrigella Haw.
Phyllonorycter platani Stgr.
Phyllonorycter populifoliella Tr.
Phyllonorycter quercifoliella Zell.
Phyllonorycter screberella F.
Phyllonorycter spinicolella Zell.
Hypera adspersus F.
Apanteles sp.
*Phyllocnistis labyrinthella Bjerk.

Epilampsis tadici:

Lithocolletis populifoliella Tr. (Delucchi 1954)
*Phyllocnistis labyrinthella Bjerk.
*Phyllocnistis suffusella Zell.
*Lyonetia clerckella L.
*Rhynchaenus populi Fbr.

Epilampsis gunholdi:

Lithocolletis joanmisi Le March (Delucchi 1954)
Lithocolletis nicellii ST. (Delucchi, 1954).
Lithocolletis tenerella De Joan (Delucchi, 1954).
Lithocolletis carpionicolella ST. (Delucchi, 1954).
*Phyllocnistis labyrinthella Bjerk.
*Lyonetia clerckella L.
*Rhynchaenus populi Fbr.

Epilampsis boops:

Rhynchaenus fagi L.
*Rhynchaenus populi Fbr.

Epilampsis mirabilis:

*Phyllocnistis labyrinthella Bjerk.

Closterocerus trifasciatus:

Lyonetia clerckella L.
Tischeria complanella Hb.
*Phyllocnistis labyrinthella Bjerk.
*Phyllocnistis suffusella Zell.
*Rhynchaenus populi Fbr.

Tetrastichus xanthops:

Scolioneura betulae Zadd.
Lithocolletis sp.

Fenusa ulmi Sund.
Phanomeris phyllotomae Mues.
Phyllotoma nemorata Fall.
Lyonetia clerckella L.
*Phyllocnistis labyrinthella Bjerk.
*Rhynchaenus populi Fbr.

Tetrastichus femoralis:

*Phyllocnistis labyrinthella Bjerk.
*Lyonetia clerckella L.
*Rhynchaenus populi Fbr.

The examined hosts

The four hosts are all leaf-miners, and occur in such abundance that they probably are important to the parasites. Accordingly, these hosts are given a more thorough treatment. The biology of these hosts is briefly:

Phyllocnistis labyrinthella Bjerk. (Lep.)

The biology of this moth has been studied before (Sundby 1953). The moth hibernates, and in the south of Norway oviposition takes place in the first half of May, just as the leaves of the aspen sprout. The larva produces an epidermal linear mine, leaving the cuticle only. The duration of the larval stages is about 16 days. The pupal stage lasts about one month. The emergence of the moth takes place within the first half of July, the exact time being somewhat dependent on the temperature of the season. During the larval period, the larva grows from about 0.6 mm to 4.5 mm in length. The mine is found on both sides of the leaf. The moth has only one generation a year. Very few larvae have been found in the last half of the summer, i. e. after the emergence in July.

The pupation takes place in a pocket, preferably at the leaf edge.

In Trøndelag, the northern part of the attacked territory, the emergence of the moth may take place from the first half of July to the middle of August, the time varying according to local conditions.

Phyllocnistis labyrinthella lives mainly on *Populus tremula*. The moth has also been found on 9 different species of the genus *Populus*. Since 1953 *Phyllocnistis labyrinthella* has also emerged from leaves collected from *Salix pentandra* L., *Salix viridis* Fr.

a hybrid between *Salix alba* L. and *Salix fragilis* L., different varieties of *Malus domestica* Borkh. and *Ribes nigrum* L. The distribution of this moth is indicated on the map (fig. 33).

Phyllocnistis suffusella Zell. (Lep.)

This moth has much the same biology as *Phyllocnistis labyrinthella* (Sundby 1953). It mines the leaves of different species of *Populus*, and has only been observed in the territory around Oslo. The moth has two generations a year.

Lyonetia clerckella L. (Lep.)

The biology of this species has been studied by Kemner (1926). The moth hibernates, and oviposition probably takes place in the first days of June. According to Kemner, the development of the egg lasts about 14 days, the larval stage about 20 days, and the pupal stage 14 days; i. e. the whole development lasts about 50 days. The larva makes a full-depth, linear mine, leaving the epidermis only. Before pupation, the larva leaves the mine and makes the cocoon on either side of another leaf. During the larval period, the larva grows to a length of 6 to 7 mm. According to Kemner, the moth has 2 to 3 generations a year in Sweden. Two generations a year have been observed in the south of Norway. Larvae were found mining during the last half of June, the first half of July and throughout August. The first generation emerges in July, the second in September. The third pupates in November.

The oviposition lasts about 3 weeks, and different stages of the development may be studied at the same time. In 1954, copulation of the moth, different larval stages, and pupae were observed on August 16th. On the whole, the larvae found on *Betula verrucosa* Ehrh. were younger than those on *Prunus cerasus* L. It has been impossible to find evidence of the existence of the third generation Kemner observed in Sweden.

In the area of Trøndelag, the moth *Lyonetia clerckella* has only one generation a year. In 1954 small larvae were found in the last days of June and the first days of July. In 1955 larvae were found mining throughout July, and oviposition was not found later that year. The attack on *Prunus padus* has been very heavy during the years of the present examination, leaving hardly any leaf without mines. Few new leaves showed no sign of attack. A few of the moths produced eggs the summer they emerged. In Trøndelag on July 9th 1954, some pupae of *Lyonetia clerckella* were collected, which emerged one week later, on July

16th. On July 19th, moths from the same samples were placed isolatedly with unattacked leaves of *Prunus padus* and *Prunus cerasus*. Mining larvae were found 3 weeks later on the leaves. Under the laboratory conditions, these moths gave origin to a new generation the same year, while this was not the case under the natural conditions in Trøndelag.

In Norway, *Lyonetia clerckella* has been found mining on: *Prunus padus* L., *Prunus avium* L., *Prunus cerasus* L., *Prunus domestica* L., different varieties of *Malus domestica* Borkh., *Betula verrucosa* Ehrh. and *Sorbus aucuparia* L. In addition Kemner mentions *Crataegus, Sorbus suecica* and *Cotoneaster* as host plants in Sweden. In this country *Lyonetia* has not been found on these plants. Contrary to the author's observation above, Haanshus (1933) has not found *Lyonetia clerckella* in Trøndelag, nor in Møre, but in the whole of southern Norway. The moth thus seems to have a rather continuous distribution in the country, but the occurrence is on the whole moderate. Some places there has been some attack, as in Østfold, south of Telemark, Agder and Sogn, but the intensity of the attack has been diminutive. In Trøndelag, on the contrary, there has been a great devastation of *Prunus padus*, while other host plants as e. g. *Prunus cerasus* were only slightly attacked. north of Levanger the attacks were observed to be very slight.

Rhynchaenus populi Fbr. (Col.)

The different species of the genus *Rhynchaenus*, have been studied earlier. Our knowledge of *Rhynchaenus populi* is essentially due to Trägårdh (1910). He called the genus *Orchestes*, but later Oldham (1928) has drawn attention to the fact that the name *Rhynchaenus* was used by Clairville 1798. Trägårdh described the different stages of the larva, the pupa, and the character of the mining activity. He has made only a few observations of the duration of the development. The weevil hibernates, and appears on the trees just after shooting of the leaves. In 1954 the beetles were found on the trees in the last half of May, in 1955 somewhat later. Immediately after emerging, they begin to feed on the new expanding leaves, and mating occurs immediately afterwards. Before the oviposition, the female makes a small cavity in which she places a single egg. These holes are lighter in colour than the feeding holes. On the whole, *Rhynchaenus populi* feeds on the first expanding leaves, and places the eggs on buds which sprout later on, but one may often see both feeding and egg-cavities on the same leaf. On each leaf it is usual to find 10–20 eggs. Only a few of these develop. The egg is oval, with a length of about 0.40 mm, and a breadth of about 0.32 mm. The first eggs are deposited during the first days of June, and the first mining activity was observed at the end of June, about 3 weeks after oviposition. The larva consumes the surrounding tissue, and makes a blotch mine. While the mine still is small, the epidermis, which separates the larva from the outer surface, is smooth, but later the cuticle rises above the surface. The mine has no distinct form, but in most of the leaves the larva only mines on one of the halves, and does not overstep the mid-vein.

The duration of the mining activity is about 3 to 4 weeks. In 1954, full-grown larvae were found on July 20th. On August 2nd, most of the larvae had pupated. The duration of the pupal stage is short. In 1954, the first emerged beetles were found on August 4th, about two weeks after the full-grown larvae were observed. The full-grown larva has a length of about 3.5 mm. *Rhynchaenus populi* like other species of the genus has only one generation a year.

Trägårdh (1910) states that the host plants of *Rhynchaenus populi* are species of *Salix* and *Populus*. In this country it has been found on *Salix pentandra* L. only. *Rhynchaenus populi* has a wide distribution. Earlier it has been found in the south/southwest of Norway (Strand, personal communication). The last years it has been found mining near Oslo, in the neighbourhood of Arendal, and in North of Trøndelag. The leaves turn brown during the mining period, a few green leaves only remain on the attacked trees.

The population density of Phyllocnistis labyrinthella

The intensity of the attack of *Phyllocnistis labyrinthella* on the aspen, may be understood as: 1. The attack of the moth, i. e. the number of eggs on each leaf, or 2. the effective attack, i. e. the devastation of the mining larvae (Sundby 1953). In 1950–51 the effective attack was partly expressed by the percentage of the leaves with mine channel on each side, mine channel on one of the sides, and the leaves unattacked, partly by the number of larvae on each side of the attacked leaves. Later the examination territories have been enlarged, and a continuous investigation of the moth's attack has been impossible. The size of the moth's population is here partly expressed by the percentage of leaves with mine channel on both sides, with mine on one of the sides, and by the leaves unattacked, partly by the number of emerged animals. These factors are possibly measured after the emergence of the moths in July, and without any continuous examination during the developing period.

The three areas chosen for these investigation are characterized in the following:

1. In the territory around Oslo, the attack of the moth has been nearly constant during the last years, and the neighbouring areas too have a vast devastation of *Phyllocnistis labyrinthella.*
2. The territory in Telemark is one of the areas with the limits of the great attack.
3. In the territory in Trøndelag, the two moths *Phyllocnistis labyrinthella* and *Lyonetia clerckella* are found side by side in great numbers, the first mining on *Populus tremula,* the latter on *Prunus padus.*

The intensity of the pest attack in these three territories in terms of leaves attacked on both sides, is seen in figures 16 to 18. Tables 5 to 7 show the whole counted material.

Great variation is found in the pest attack from station to station within the same territory. In the area around Oslo for instance, the percentage of unattacked leaves the same year may vary from 2.7 % to 68.8 %. The examinations seem to show that the bulk of the moth oviposit on the same tree on which they have developed and great variation of the pest attack on trees at a distance of few hundred meters is observed. This may possibly explain the variation.

The material from Telemark shows the attack to decrease rapidly toward the limit of the attack. The boundary line is often sharp, which is the case along all three lines where the count was made. Some places the attack is lighter in spite of there being no limit zone. The reason is supposed to be variation in the conditions during the oviposition periods. The percentage number of leaves attacked on both sides varies from about 90 within the great attacked area to about 2 near the limit zone.

In Trøndelag a real pest attack is limited to a relatively small area. The population is small compared with the count in Telemark, but also here a variation in numbers is found.

Little change in the successive generations of the moth is found during the investigated periods. A slight decrease is indicated the two last years in the territories under review.

This the author will explain as the influence of the weather during the oviposition period. The investigation shows that moths are strongly dependent on the weather in this period. In 1950 a number of 5 eggs on each side of the leaves were common, as many as 13 were observed (Sundby 1953). The oviposition period was short that year, but the weather was warm and dry. In 1955 the temperature in May and June was low. Eggs were deposited until the end of June, while the first sprouted leaves avoided oviposition. The count in the territory of Oslo shows 0 and

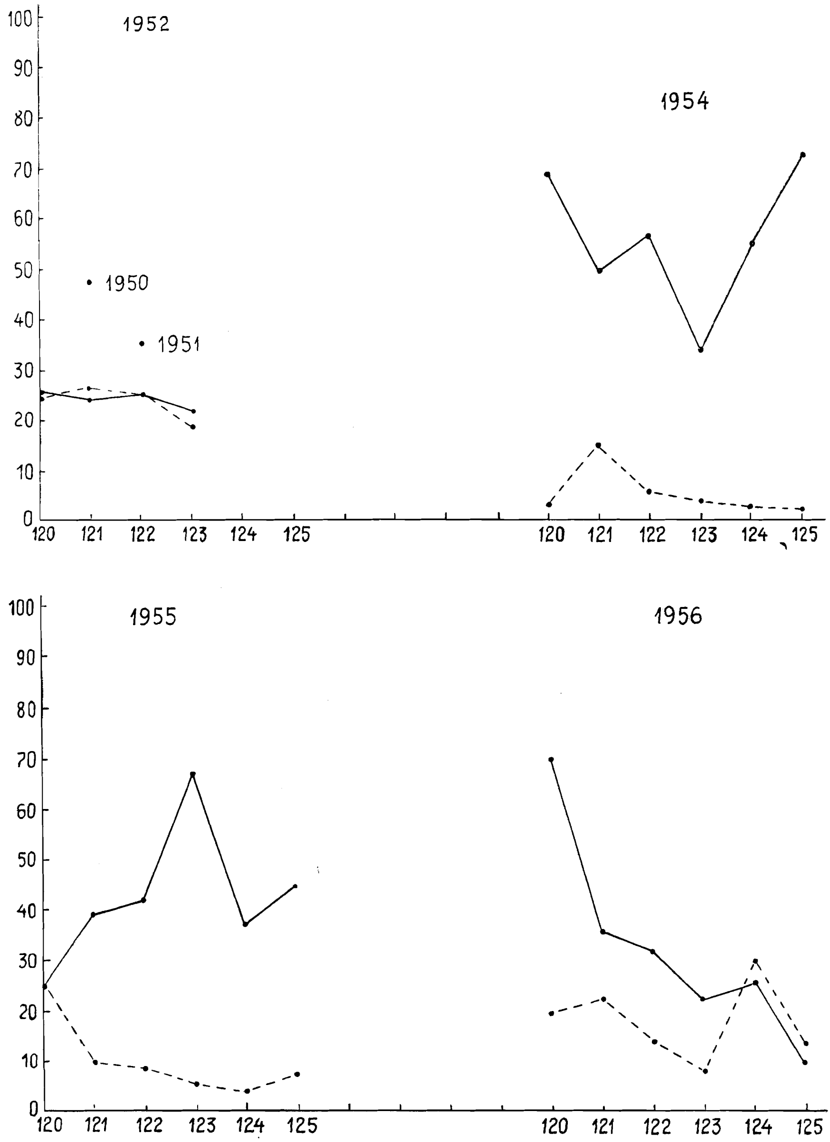

Fig. 16. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Oslo.
———— Percentage of leaves attacked on both sides.
— — — Percentage emerged parasites.

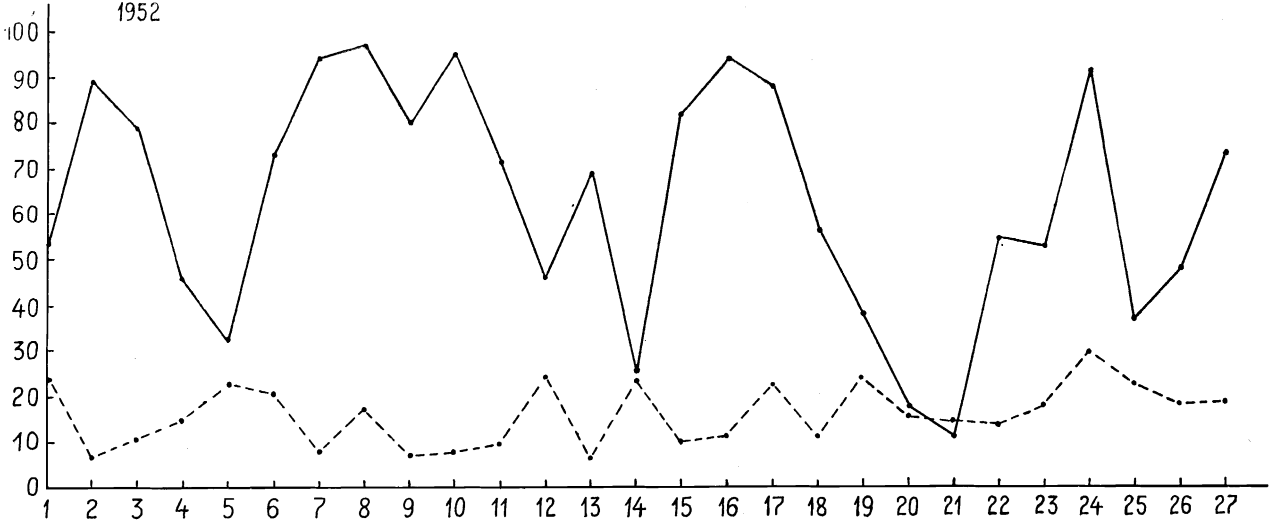

Fig. 17a. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Telemark. First line. Stations.
———— Percentage of leaves attacked on both sides.
— — — Percentage emerged parasites.

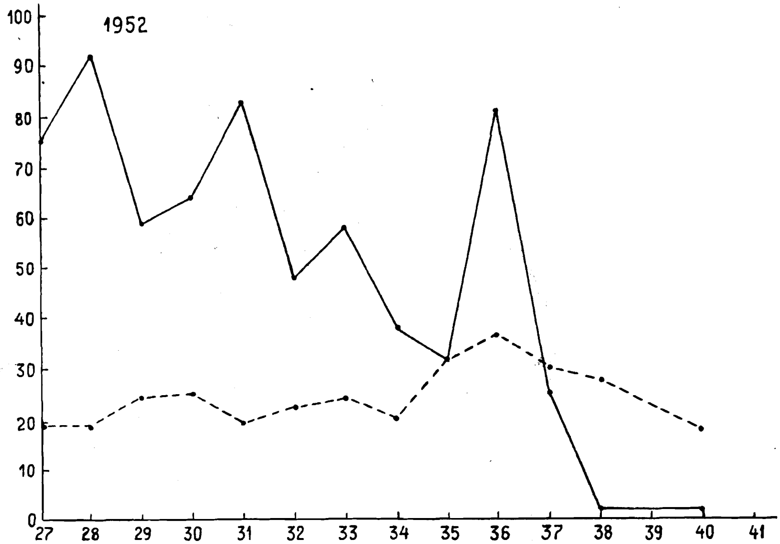

Fig. 17b. The population density of *Phyllocnistis labyrinthella* and thë parasitic frequency in the territory of Telemark. First line continued. Stations 27–41.
——— Percentage of leaves attacked on both sides.
– – – Percentage emerged parasites.

1 egg on each side of leaves to be most common. The highest number found was five on one leaf side.

A future year with favourable conditions during the oviposition period will most probably give a higher population density. Oviposition females are always present.

The limit of the attack is faintly translocated from year to year. This is the case both in the territories in Telemark and Trøndelag. The last year the moth was found in greater numbers outside the pest attack, but any raise in the mining leaves within the attacked territories is not found.

The number of animals emerged from each single leaf is seen in figures 19–21. The term animal is here used for all the animals emerged, whether moth or parasites.

In accordance with the leaves attacked, a clear decrease is found in the number of animals toward the limits of the attack. As a result of the great devastation of the moth, a small number of animal emerged. The greatest number of animal emerged on each single leaf is found in Trøndelag with a size of 2.4.

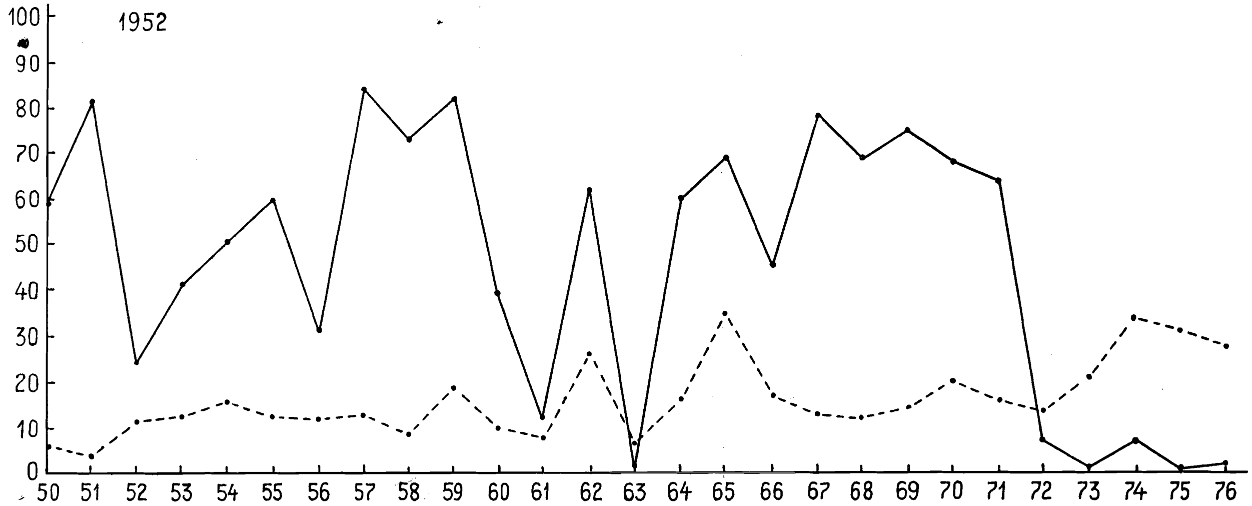

Fig. 17c. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Telemark. Second line.
——— Percentage of leaves attacked on both sides.
– – – Percentage emerged parasites.

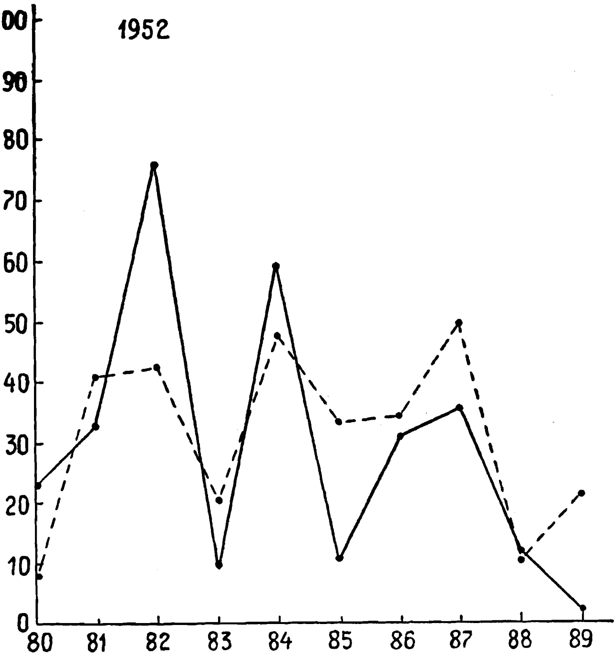

Fig. 17d. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Telemark. Third line.

——— Percentage of leaves attacked on both sides.

– – – Percentage emerged parasites.

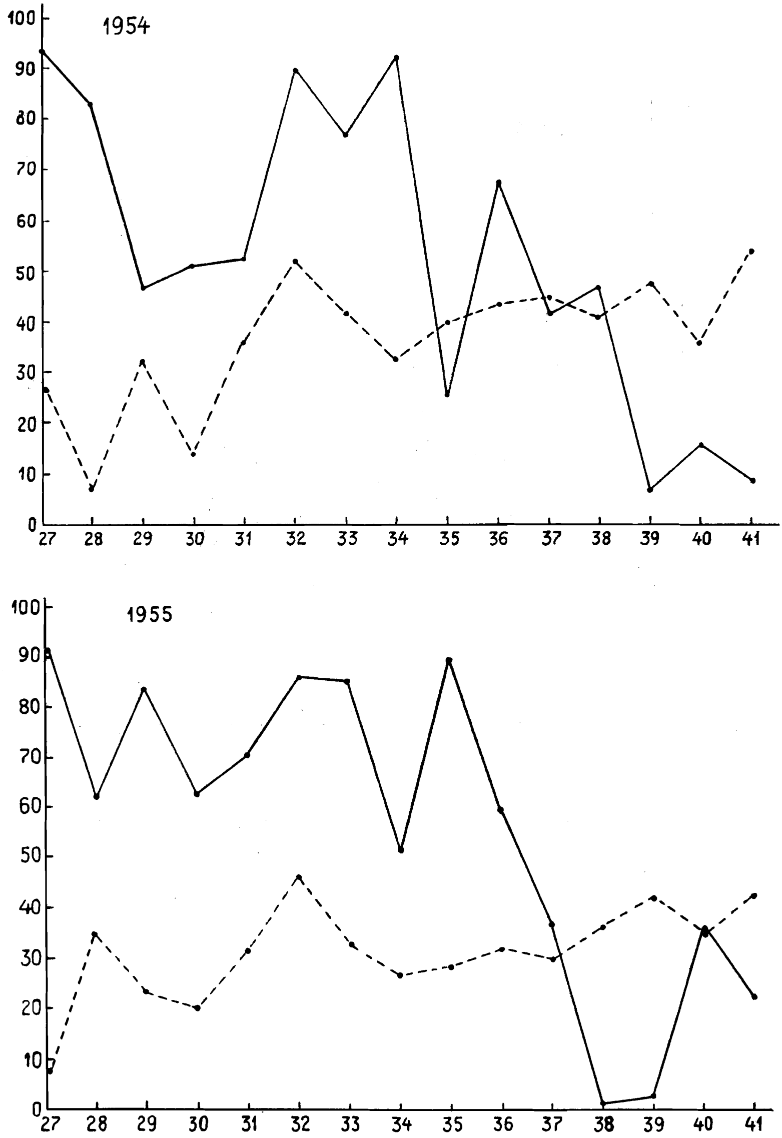

Fig. 17e. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Telemark. Stations 27–41, 1954–55.
——— Percentage of leaves attacked on both sides.
– – – Percentage emerged parasites.

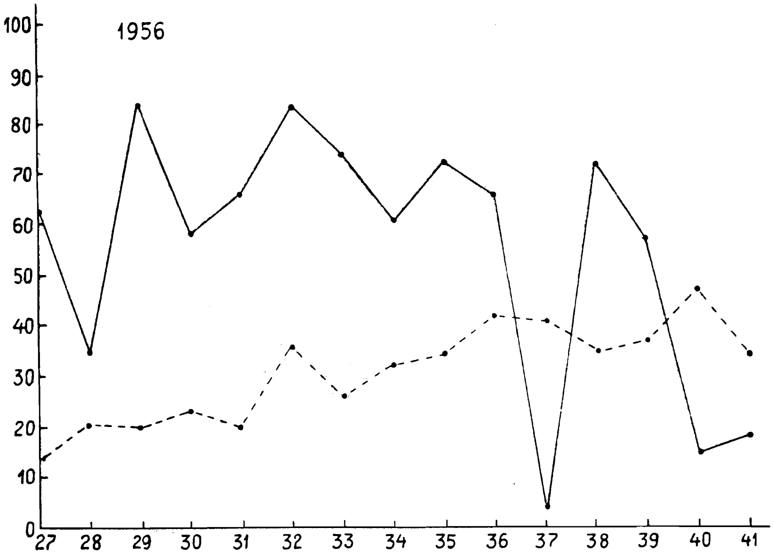

Fig. 17f. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Telemark. Stations 27–41. 1956.
——— Percentage of leaves attacked on both sides.
– – – Percentage emerged parasites.

On each side of the leaf of the aspen of usual size, a number of 2 larvae may carry through the development. One would expect a greater number of animals to emerge from each leaf, but there are unattacked leaves, and leaves with attack on one side only. This explains the comparatively small number of emerged animals from each single leaf.

This indicates that the population density of *Phyllocnistis labyrinthella* is greatest in Telemark, smallest in Trøndelag, and all over it has been nearly constant during the investigated years. The attacks nearly always decrease rapidly. The climate is observed to have a marked effect on the oviposition. The small fluctuation of the population density, and the translocation of the limits show that the moth is influenced by «regulating factors».

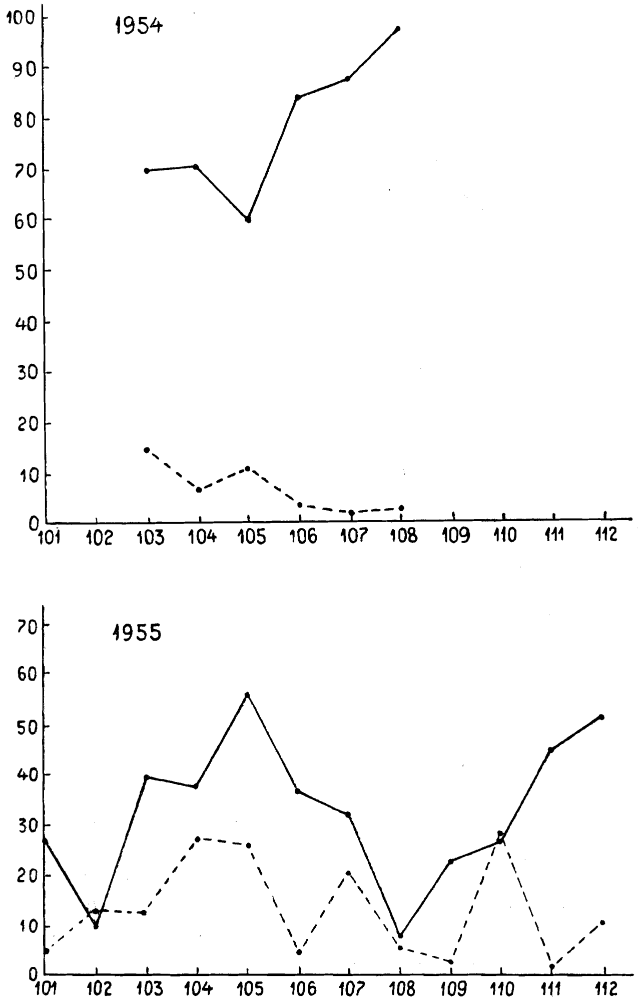

Fig. 18a. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Trøndelag 1954—55.

———— Percentage of leaves attacked on both sides.

— — — Percentage emerged parasites.

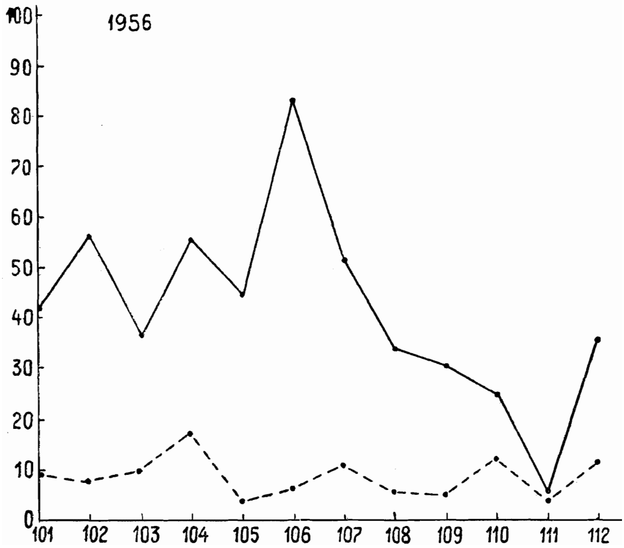

Fig. 18b. The population density of *Phyllocnistis labyrinthella* and the parasitic frequency in the territory of Trøndelag. 1956.
——— Percentage of leaves attacked on both sides
– – – Percentage emerged parasites.

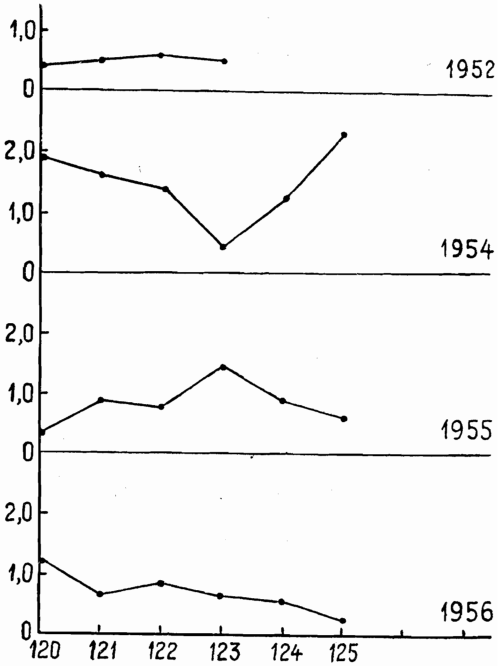

Fig. 19. Number of animals (moth and parasites) emerged from each leaf. The territory of Oslo.

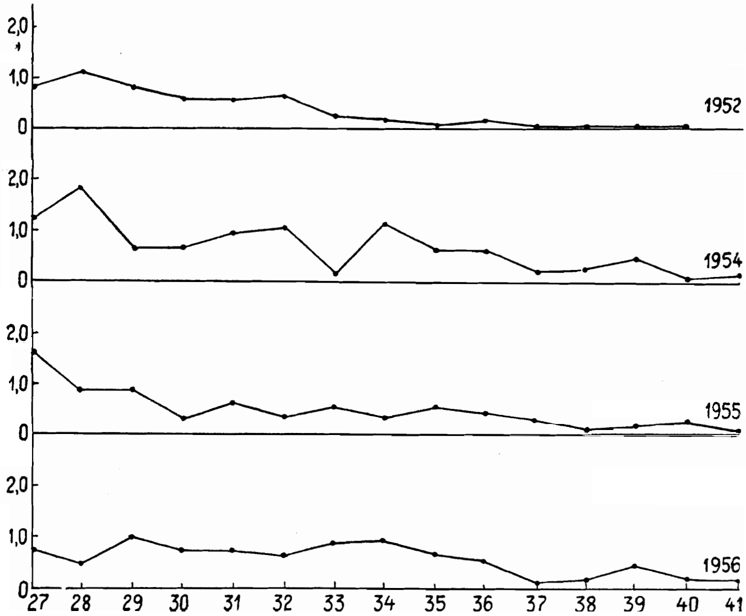

Fig. 20. Number of animals (moth and parasites) emerged from each leaf. The territory of Telemark.

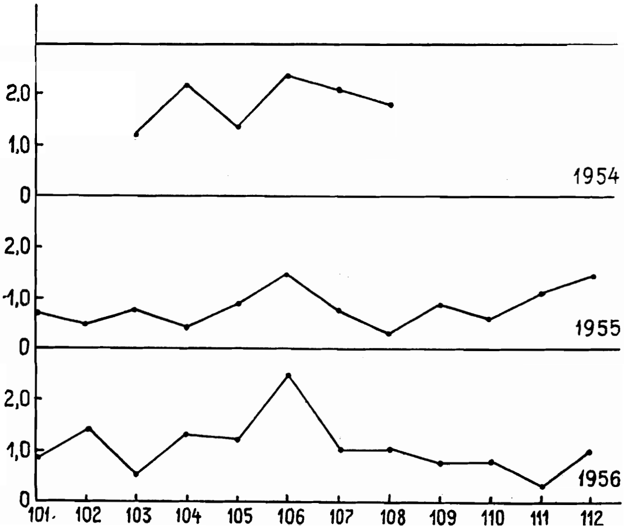

Fig. 21. Number of animals (moth and parasites) emerged from each leaf. The territory of Trøndelag.

The oviposition and emerging time for the different hosts

As mentioned, the moth *Phyllocnistis labyrinthella* has only one generation a year. The oviposition in the south of Norway on an average takes place on May 15–20th, the pupation on June 5–10th, and the emergence on July 10–20th (fig. 22). The moth *Lyonetia clerckella* has two generations a year. Larvae are found in mining activity in the last part of June and the first half of July, while the second generation are mining in the first of August. The oviposition period lasts several days, and at the same time different developing stages are observed. The weevil *Rhynchaenus populi* is found mining during the whole July. As mentioned, only one generation has been observed.

In this territory, the attack on *Phyllocnistis labyrinthella* is possible in the last of May and the first days of June, on *Lyonetia clerckella* the last of June and the middle of August, and on *Rhynchaenus populi* the most part of July.

In Trøndelag the larvae of *Phyllocnistis labyrinthella* is found most of June, while the larval stages of *Lyonetia clerckella* last from the middle of June to the middle of July.

The parasites have the possibility to deliver their eggs in or at *Phyllocnistis labyrinthella* in the first of June and on *Lyonetia clerckella* between the last days of June to the middle of July.

The behaviour of the parasites

The examined species

The parasites used in the laboratory examinations are partly entoparasites, partly ectoparasites. The genera *Closterocerus* and *Epilampsis* comprise the entoparasites. The ectoparasites all belong to the genera *Cirrospilus*, *Eulophus* and *Tetrastichus*.

As mentioned before, the efforts to make all the parasites attack the moth *Phyllocnistis labyrinthella* in the laboratory have not been successful. Parasitations have been carried through with the following species: *Cirrospilus vittatus*, *Cirrospilus pictus*, *Cirrospilus elegantissimus*, *Cirrospilus subviolaceus*, *Eulophus pectinicornis*, *Eulophus longulus*, *Closterocerus trifasciatus*, *Epilampsis tadici*, *Epilampsis gunholdi*, *Epilampsis boops*, *Tetrastichus xanthops* and *Tetrastichus femoralis*. As to *Eulophus straminiepes* and *Sympiesis sericeicornis* the attempts of parasitations have all failed. The females have attacked the host, but no eggs have been laid. With *Epilampsis mirabilis* no experiments have been tried owing to shortage of specimen.

Mating

In the examined species the mating takes place on the first days after the emergence. The exact duration of the mating

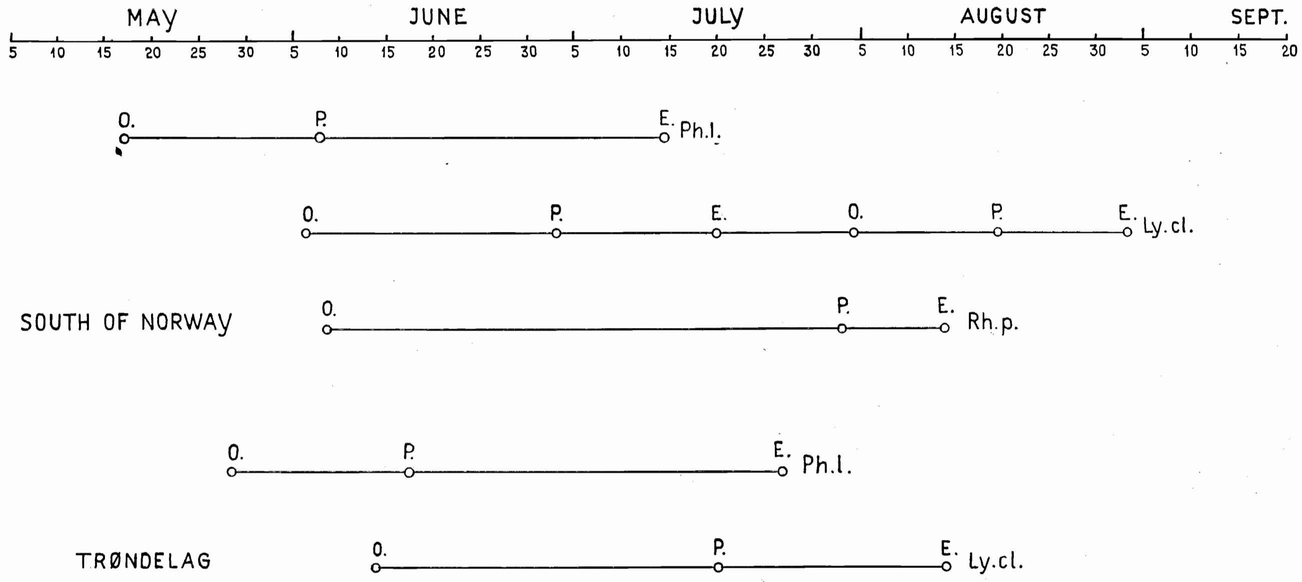

Fig. 22. The oviposition and emergence time for the different hosts. O: Oviposition. P: Pupation. E: Emergence. Ph. l.: *Phyllocnistis labyrinthella*. Ly.cl.: *Lyonetia clerckella*. Rh.p.: *Rhynchaenus populi*.

has not been measured, but it lasts several hours. It seems that the females copulate only once, as Proper (1931) has found for *Eupteromalus nidulans* (Thomson).

In the parasitic *Hymenoptera*, the fertilized eggs usually develop into females, the unfertilized produce males. Fertilized and unfertilized eggs are delivered alternately.

The experiments show that the females certainly do not copulate during the oviposition period. In 1954 an *Eulophus pectinicornis*, which was caught in the field, had an oviposition period of 18 days, the number of egg laid in this period was 33. The egg oviposited the last day developed into a female. The same conditions are observed for other species. *Cirrospilus pictus* with an oviposition period of 46 days, delivered 45 eggs. A female was developed from an egg oviposited the 26th day. As to *Epilampsis tadici* the last delivered egg of a number of 38 produced a female. These ovipositing wasps had copulated before the examination started in the laboratory. Female progenies indicate that the eggs were fertilized. During the laboratory research, unmated females of the same species oviposit, but the progenies developed into males.

The conclusion may be drawn that mating is unnecessary for the oviposition, and that the females need not copulate during the oviposition period. Mating before the deposition of eggs, produces females as well as males during the whole oviposition period.

Feeding habits

According to the oviposition habits, the parasitic *Hymenoptera* may be grouped in two categories, those in which oogenesis is largely completed before oviposition and those in which oogenesis continues after the deposition of eggs has commenced. The females of the first group are shortlived and take little if any food. The latter group comprises the longlived females, and in many species the deposition of a full complement of eggs depends on a further host-feeding by the female (Flanders 1950).

The parasitic species brought to a successful parasitation in the laboratory belong to the last group. The females feed on the host before and during the oviposition period. As seen in table 1 the first feeding occurs on the day the hosts are introduced into the glass tubes with the parasitic females. Only with *Cirrospilus pictus*, *Epilampsis tadici*, *Tetrastichus xanthops* and *Tetrastichus femoralis* the first attack occasionally occurs a day later.

The feeding proceeds as follows: As soon as the female gets contact with the leaf, she moves rather slowly around on the surface, tapping continually against it with the ends of her antennae (fig. 24). She moves back and forth, sometimes on the upper, other times on the under side of the leaf apparently searching for a host. When a mine is encountered, the female follows this until she hits upon the larva. The time spent in localizing the host differs considerably. During the laboratory experiments this exploration lasts from 2 min. to 1 hour (tab. 8). As soon as the female attains contact with the host, she moves forward and backward several times above the larva, with the antennae towards the leaf, as if to certain the position of the host within. Then, bending the abdomen downward until the tip touches the leaf, she inserts the ovipositor into the larva (fig. 25). Afterwards she brings the abdomen back to a horizontal position. There seems to be no rules as to where the larva is punctured, the ovipositor being forced into the front as well as into the hind part of the body. The feeding puncture may last as short as 5 seconds or as long as 7 minutes (see tab. 8). During this time, the ovipositor is generally moved in different directions in the larva, perhaps to drain the host more effectively of body fluids. The ovipositor is then retracted quickly and a little drop of fluid from the larva rises to the surface of the leaf. The female turns about, applies her mouth parts against the drop and begins to lick until the drop is consumed (fig. 26). This may last from 5 to 30 minutes. It seems as if the female imbibes the liquid. Sometimes the juice does not rise before the female places her mouth against the puncture in the cuticle. If the drop is small, the female usually stings again. On a few occasions it was observed that the female left the host before the whole drop was consumed. Very often the feeding puncture has no result. On the withdrawal of the ovipositor, the female gets no fluid. In the present case, the female tries again until the fluid is obtained. The behaviour described is typical for attacks on *Phyllocnistis labyrinthella*. The habits are much the same as those found for other species (Blunch 1951, Edwards 1955, Proper 1931), but contrary to these authors, no feeding tubes could be observed. On the other hosts, the sting for feeding is somewhat quicker, compared to that on *Phyllocnistis labyrinthella*, but the nature of the act is the same. The host *Phyllocnistis labyrinthella* is usually attacked from the same side of the leaf where it is mining, but attacks from the other side have also been observed. The host *Rhynchaenus* is generally attacked from the upper side, while *Lyonetia clerckella* is attacked from both sides of the leaf.

Egg production

The feeding just described, is not necessary for the support of life.

According to Nicholson (1954 a), the adults live at least as

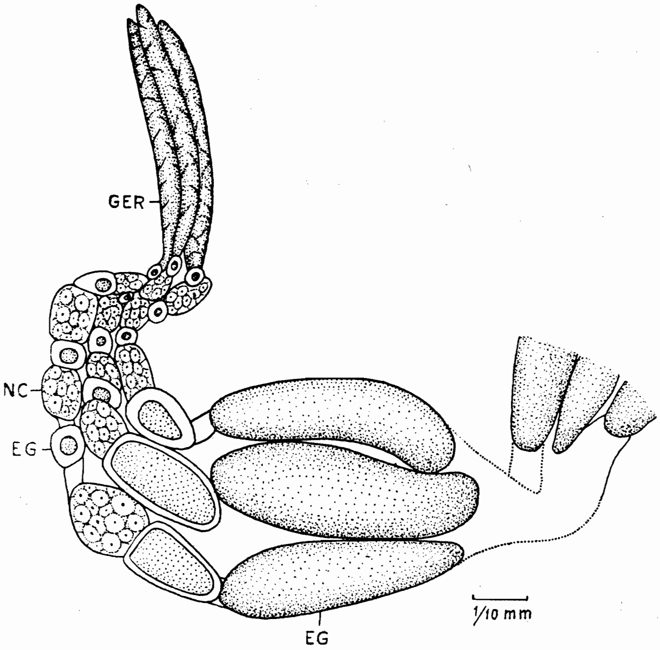

Fig. 23. The ovary of *Eulophus pectinicornis* with three nearly mature eggs. The female fed on honey a week. EG: Eggs in different stage of development. NC: Nutritive cells. GER: Germarium with undifferentiated cells, which later are transformed into egg cells and nutritive cells.

long when supplied with water and sugar, as they do when given protein food, but the latter is necessary for the egg production. Correspondingly, the parasitic females stay alive for several weeks during the laboratory examination on a diet of honey only (*Cirrospilus vittatus* ♀ 15/7–26/9), but the blood meals have a marked effect on the egg production.

The shape of the ovary (fig. 23) in the investigated species is similar to that found in *Monodontomerus dentipes* Boh. (Bucher 1948). Each ovary consists of 3 ovarioles, which are of the polytrophic type.

The ovary of the newly emerged female contains no egg (controlled by dissection). The first mature egg is found when the female, fed on honey only, is 3 to 4 days old. The egg production starts independent of the mating and the presence of the host. After a week the ovary of *Eulophus pectinicornis* may be in the state shown in figure 23. Six mature eggs are present. In the different females of the same or other species, the number of eggs is observed to be 2 to 6 after a week.

As seen in table 8 the oviposition starts the same day or a few days after the admittance to the host. The time depends on the duration of the period between the emergence of the female, and the time when the host larva is placed in the glass-tube. The longest time which elapses from contact with the larval host until oviposition is found in *Cirrospilus elegantissimus*. The period is 29 days. Host feeding always precedes oviposition as found in some other species (Flanders 1942). But the feeding seems to be unnecessary for the production of the first eggs. These eggs are delivered shortly after the first contact with the host, and the examination of the ovaries of females fed on honey only shows that the development of the first eggs may be completed before host feeding. The relation between reproduction rate and diet has been reported for different species (*Mormoniella vitripennis* (Edwards 1954, Roubaud 1917), *Habrobracon juglandis* (Grosch 1950)). These authors have found a heavy rise in the egg-production rate though the parasite's host blood feeding. The same seems to be the case with the present investigated species. Females fed on honey only and on honey and host blood show some difference in the condition of the ovaries. Specimens from the latter group have a greater number of mature eggs at the same time in the ovarioles than the other. According to Flanders (1942) the oogenesis in the pregnant females of the parasitic *Hymenoptera* proceeds at a continuous constant rate, if not completed before emergence. The material used in the production of the egg consists largely of the nitrogenous food consumed during its larval or adult life. On the other hand, some species are reported to require carbohydrates (honey) only for the total oviposition (Flanders 1942).

The oviposition can possibly be carried through without host feeding. The present investigation shows as mentioned some difference between the two groups on different diet. This before the deposition of eggs has commenced. The females which have consumed honey only feed on hosts blood as soon as they get contact for egg disposal. Thus they turn over to the host feeding group, and it is difficult here to determine the importance of the oviposition for the egg production. The present investigation provides no evidence about the necessity of the host's blood for the egg production in the examined species.

The disposal of the egg by the hymenopterous females occurs either by deposition or by absorption (Flanders 1942). According to different authors, a resorption of the mature eggs occurs synchronous with the ovulation in the absence of hosts. The resorbed egg leaves no trace in the ovariole (Edwards 1954), but during the present work no attention has been devoted to this factor. According to Flanders (1950) the females appear to have fewer ripe eggs at a time and to be longer-lived in the absence of host. It has been observed during the present work that the parasitic female usually fed at the first host contact if the host has been detained several days. A *Cirrospilus pictus* was isolated 16 days. On the first day of contact she fed, on the second oviposited. Previously this female had delivered 36 eggs.

The present investigation shows that ovulation starts shortly after the emergence of the female, independently of mating and the presence of host. The host feeding has an effect on the rate of egg-production, but the necessity of the host blood for the total ovulation is undetermined. Under certain conditions, this makes the females more effective.

The oviposition habits

Oviposition has been studied most closely with *Phyllocnistis labyrinthella* as the host, but observations have shown that the habits of the female are essentially the same when other hosts are attacked. The searching for the host takes place in the same manner as described for the feeding, but the oviposition act has another character. There is a distinct difference between the ento- and ectoparasitic species.

Entoparasites

The two entoparasitic genera are as mentioned *Epilampsis* and *Closterocerus*. As soon as the females of this wasps encounter a host, they rush back and forth several times. The antennae are kept down against the leaf and are in constant movement. After preliminary antennal examination, the female bends her abdomen downward, and usually probes with the ovipositor until an entry is effected before she inserts her ovipositor into the host. Sometimes she moves the abdomen from one place to another before stinging. In the first stage of the behaviour pattern the ovipositor is most frequently stung only halfway into the larva, and the female remains quiet a short time only with the antennae in slight drumming. (This word see Edward 1955). During the second phase the egg is deposited. The ovipositor is inserted deeper, frequently in full length, and the antennae stop drumming. The wings have a horisontal position. Then the part of the abdomen nearest to the base of the ovipositor is expanded, and the egg is pressed into the larva. During this stage of the act, the abdomen moves rhythmically and the ovipositor works slightly up and down. Immediately after the deposition of the egg the ovipositor is withdrawn slowly, and the tip of the abdomen is bent down to the opening in the cuticle. The female closes the opening carefully, and before leaving the host, checks if the closure is effective.

The whole oviposition lasts from 31 seconds to 2 minutes and 55 seconds (tab. 8). The female may from time to time put the ovipositor into a larva, but takes it up again without depositing any egg. This sting takes about 26 seconds. The closure of the opening in the cuticle takes about 20 seconds.

Usually the egg is placed in a larva of the late third stage, in the pre-pupal stage or in the pupa. The females used in the laboratory were observed to attack larvae of the early third stage, but most frequently the females leave these small larvae without any oviposition. As mentioned, *Phyllocnistis* is practically always attacked from the side of the leaf where the larvae are mining. The pupa is attacked from different places on the pocket, one place seems not to be preferred to another.

The egg is usually placed in the body cavity, and in the front as well as in the hind part of the body. Exceptionally the egg has been found in some of the organs, for instance in the salivary gland. The female has the ability to bend the ovipositor in nearly all directions, and often pushes away the organs before the egg is laid.

During the oviposition period, the larvae of *Phyllocnistis labyrinthella* remain quiet. Only the pupae make some resistance at first. As soon as the deposition of the egg is carried through, and the female has left the host, the larva starts the mining activity.

The entoparasitic females make no preparation for the oviposition. The egg is usually deposited at the first sting, and the host continues to live until the parasitic larva partly has consumed the host. The oviposition is completed by a closure of the opening in the cuticle.

Ectoparasites

As distinct from the entoparasites, the ectoparasitic females prepare the oviposition. Here the egg is placed beside a host which is alive at the time of the attack, and perhaps in mining activity. The eggs have no hooks. If no measure were taken, the host might leave the place where the egg is deposited, and the newly hatched larva would be without food. Before oviposition the «paralysing» occurs. These punctures, usually two to three in numbers, last from 2 seconds to 3 minutes and 12 seconds (tab. 8). The duration of the puncture of the larvae of *Rhynchaenus* is longer because the latter makes a blotch mine and enable these larger larvae to move more vigorously. Some specimen as a *Eulophus longulus* for instance, stung the host at first in the frontal, then in its distal part, but usually the puncture occurs anywhere, and the ovipositor is put only slightly into the host during this act. There is no closure of the opening in the cuticle afterwards.

In accordance with earlier investigation (Proper 1931), these punctures, preliminary to oviposition, produce a state of permanent paralysis. The question is whether these stings have a more marked effect. Larvae being in mining activity at the time of attack become quiet shortly after these punctures. The mining activity usually ceases when the stinging starts, but some weak movements in the host have been observed as long as 70 minutes after the attack. Later no indication of life is seen. By dissection of the larval host one day after the attack, before the hatching of the parasitic egg, the host seemed dead. The different organs had started going into dissolution, and the Malpighian tubules and the salivary glands showed no movements. This is the case with the host's larva attacked by different parasitic species. Two to three days later the host turns brown, and the darkening proceeds during the whole parasitic feeding period (fig. 32).

According to Proper (1931), it seems as if the state of «paralysis» produced in the larvae by the female parasite is not a result of a mechanical puncture only. As Proper has pointed out, a mechanical puncture does not have the same effect as the attack by the parasitic female. Some larvae pricked with a micro pin, mechanically much similar to the sting of the ovipositor, lost a drop of juice only, and after a short time regained their mining activity. Of 8 thus punctured larvae, 2 died, the latter dried out and shrank. The larvae punctured by the female of the ectoparasitic wasps do not shorten, on the contrary they seem to swell, and remain in this state (fig. 31). The larvae pricked with a micro pin, and those punctured by the female were kept under the same conditions. It may be suggested that this «paralysis» might be the result of the puncture by the female of certain areas, such as those containing ganglia for example. The present examination has found the sting occuring anywhere. Proper (1931) indicates that the female injects a substance into the host during the «paralysing» puncture. Later Flanders (1950) recorded the acid gland of the parasitic *Hymenoptera* to produce a secretion used to «paralyse» the host before or at the time of oviposition, while Beard (1952) has studied the action of the venom in *Habrobracon juglandis* Ashm. According to the present investigation, the acid secretion must be of different nature or injected in different quantity where the ecto- and entoparasitic species are concerned.

After these punctures of the host, a resting period follows. The female remains by the larva, with the antennae in constant drumming. Four to five minutes usually pass between the last sting and the oviposition. Occasionally this intermission may be of longer, or shorter duration. One minute has been observed. In advance of the oviposition the female probes the space between the host and the leaf in all directions. At times the female conveys the impression not to be satisfied with the localities around the host, she tries to sting again and again, but without any oviposition (tab. 8). A female of *Cirrospilus pictus* has been observed to try stinging 31 times before the egg was placed. According to Jacobi (1939) the females have the possibility to determine if the host is surrounded by air or not. The egg requires air around the host.

During the probing and oviposition phases, the motion of the ovipositor is seen through the leaf's cuticle. From the outside these actions look like a series of sideway movements of the parasite's abdomen.

If the host is suitable, eggs are placed. The behaviour during the first part of this act is the same as found in the entoparasitic females. Sometimes the ovipositor is stung in half its length only into the mine, and consequently the abdomen is kept in a slanting position against the leaf. In *Cirrospilus vittatus* and *Cirrospilus pictus* this attitude has often been observed. As a rule the ovipositor is inserted in its full length, and the abdomen is brought back to the horizontal position, or raised a little (fig. 27). During this act the wings are held horizontally, and the antennae are in slight vibration or quiet. The ventral part of the abdomen, i. e. nearest the base of the ovipositor protrudes and the abdomen gets a triangular shape (fig. 27). Small rhythmical movements are observed in the abdomen, and the oviposition occurs. The egg is delivered a little distance from the tip. By means of the ovipositor the egg is sometimes pushed nearer the host. The retraction of the ovipositor occurs very slowly. As in the case of the entoparasitic wasps described, the different species of *Eulophus* close the opening in the leaf's cuticle with the tip of the abdomen before leaving the host. The closening is checked. The different species of *Cirrospilus* and *Tetrastichus* leave the host without any closure.

As seen in table 8 the whole oviposition lasts from 23 seconds to 4 minutes and 22 seconds. The duration of the oviposition is about the same for the different parasitic species and the different hosts. The eggs are deposited (in the laboratory) on a fully grown larva of *Phyllocnistis labyrinthella,* at the pre-pupal or pupal stages. The wasps attack most frequently happens from the side of the leaf where the larvae are mining. The other hosts are attacked from above as well as from below. In the mine of *Lyonetia* the female inserts her ovipositor nearly parallel to the length of the host, because of the narrow mine. No particular place seems to be preferred for the oviposition. Essentially the oviposition habits agree with the behaviour reported for other parasitic species (Edwards 1955, Johnston 1915, Proper 1931).

The potential resources of the parasites

The relation between the size of the hosts and the parasites

The size of the insect parasites depends, according to earlier investigations (Salt 1941), partly on the host. The average length of the pupae of the same species depends on the size of the hosts. In the present material, one parasite only can develop to maturity at each host, and little difference in size appears between the host and the parasite.

A full-grown larva of *Phyllocnistis labyrinthella* attains a length of 4.5 mm, a larvae of *Lyonetia clerckella* 6 to 7 mm. The length of the pupae of the different parasitic species, the two mentioned moths used as hosts, may be seen in table 9. The females used in these experiments originate partly from *Phyllocnistis labyrinthella,* partly from *Lyonetia clerckella.* With a host length (*Lyonetia*) of 5.4 mm, the pupa of *Eulophus longulus* may reach a length of 2.5 mm; with a host of 6 mm, the parasite may grow to 2.7 mm in length. A larva of *Phyllocnistis* 3.3 mm in length, may give rise to a pupa of 1.77 mm. The table shows great variations in the length of the progeny. The greatest average length is usually attained by the pupae developed on *Lyonetia,* for the species *Eulophus pectinicornis* the largest pupa measured, however, is developed on *Phyllocnistis labyrinthella.* The average length of 32 pupae, collected in the field, of *Eulophus longulus* developed on *Lyonetia* is 2.6 mm. The pupal length of the same species developed on the same host in the laboratory was measured to 2.48 mm (10 pupae). During the laboratory experiments, the females have primarily attacked the host *Lyonetia* before reaching the full-grown stage. In the field the genus *Eulophus* attacks the host *Lyonetia* after it has left the mine. During the laboratory experiments the females have contacted the host of the pre-pupal stage, but without any oviposition. The moth *Phyllocnistis labyrinthella* has most frequently been attacked near the full-grown stage. The difference in size between the two hosts has during the reviewed experiments been smaller than the difference between the full-grown host's larvae. The parasitic larvae have sometimes been observed to leave the host without consuming it. According to Salt (1941), the eggs of the parasitic insect usually develop into females, when deposited in hosts of great size. The males develop from smaller hosts. Accordingly, a greater number of females should appear from the host *Lyonetia,* than from *Phyllocnistis.* The sex-ratio should be higher, and the efficiency of the parasites consequently greater.

No difference in sex-ratio of the parasites on the different hosts is observed. The largest hosts produce parasites of the greatest size, but the observations show that the two mentioned hosts contained food sufficient for the development of the parasites. No difference in efficiency according to the size of the parasites was registered.

The number of eggs

The total number of eggs deposited by the different specimens during the laboratory experiments is seen in table 10. Some of the females attack the host more readily than others, and consequently great variation is found in the number of eggs from each single female. The highest number of eggs was 58, deposited by *Cirrospilus vittatus* during a period of 40 days. The number of eggs is usually proportional with the oviposition period.

According to Flanders (1950) the number of ovarioles in parasitic *Hymenoptera* varies from 2, as in *Chelonus,* to 657 as in the trigonalid *Poecilogonatos thwaitesii* (Westw.). The last mentioned wasp is capable of depositing more than 10 000 eggs within a period of 2 weeks (Clausen 1929). The examination of the species in the present investigation, shows the different species to have a number of sex ovarioles. As mentioned, the ovarioles are of the polytrophic type, and may before the oviposition period have the condition shown in figure 23. The vitellarium contains eggs in different stages of development, the germarium undifferentiated cells which later are transformed into eggs and nutritive cells. This examination shows that it is difficult to determine the number of eggs produced during the oviposition period. The germarium contains as mentioned undifferentiated cells only, and no indication of the eggs produced is found. The oviposition period during the laboratory examination is usually 30 to 40 days (tab. 10), with a maximum of 43 days. Approximately a sixth of the females has on an average laid more than one egg a day. The greatest number a day is observed to be 8, but usually 2 to 3 eggs only are delivered. The rate of egg-deposition is seen in table 11. No rule has been found as to which part of the oviposition period the main multitude of the egg is deposited. Usually the greatest number of eggs is placed a week after the access to the host, but this naturally depends on the condition of the female when oviposition starts.

It is difficult, from the present investigation, to determine the exact number of eggs placed by a single female. The conditions during the laboratory experiments are not quite natural, and the daily egg-rate could be expected to be higher in the field. But as shown in table 11 only a few eggs are delivered the day after the main oviposition, and during the laboratory experiments the females have little trouble in finding the host. Contrary to field conditions, the wasps are partly isolated, but food is always available, and one should expect the egg production to continue independently of the presence of the host. The observed number of eggs from each single female is low compared with other parasitic species. The number of the same species in the field is possibly larger than is the case during the laboratory experiments, but the number of eggs a day indicates that the egg-rate is near to the potensial of the parasites.

A consequence of the lower number of eggs is a lower efficiency of the parasites. A full discussion of this problem will be made later in this publication.

Superparasitism

The phenomenon superparasitism is an extremely common occurrence in nature, and is well known. The word was defined by Fiske 1910 as the result when a host is attacked by «two or more species of primary parasites or by one species more than once.» Here the oviposited females are of the same or different species. Later the term multiple parasitism was suggested by Smith (1916) for that type of parasitism in which the same individual host insect is inhabited simultaneously by the progeny of two or more different species of primary parasites, while superparasitism is the phenomenon of the ovipositing females being of the same species. In both cases it is supposed that the individual host is attacked by more parasites than are able to complete their development. Superparasitism is used by the different authors if the host is attacked by the same or different females within the same species.

During the present experiments, superparasitism has been observed. As seen in table 10 the number of eggs deposited in or at a single female varies between 1 and 14, but usually one egg only is laid at each host. This is the case with the entoparasitic as well as the ectoparasitic species. Soon after the oviposition, the female leaves the host. Later she may return, but as a rule no further oviposition occurs.

Superparasitism depends upon whether or not the parasitic females are able to select healthy hosts for their progeny. According to several authors, oviposition is avoided in parasitized hosts at a part of the parasitic *Hymenoptera*. The investigators are agreed that the eggs are not distributed at random, but there are conflicting views on the nature of this behaviour, and on the cause for such rejection. Salt (1937) suggests the chemical sense as the factor here. The tormerly attacked hosts are discriminated, either on account of the odour left on the surface of the host, or the internal difference recognized at the ovipositor's penetration. The external odour passes off in time, the internal alteration on the other hand lasts. The presence of sense organs on the ovipositor of various species of parasitic *Hymenoptera* is demonstrated by Fulton (1933) and by Varley (1941). Also Jacobi (1939) indicates the presence of a chemoreseptors sense on the ovipositor. In accordance with this, Varley (1941) and Andrewartha and Birch (1954) indicate that the ectoparasitic species have no chance to avoid superparasitism. Later it has been found that also the ectoparasitic species have the possibility to distinguish between parasitized and unparasitized hosts. (Edwards 1954, Lloyd 1956, Narayanan and Chaudhuri 1954).

As to the entoparasitic species in the present material, nothing seems to deny the presence of sense organs on the ovipositor. In the case of insertion of the ovipositor into hosts already parasitized, it is usually withdrawn immediately. The ectoparasitic species were observed during the experiments to have deposited a greater number of eggs at a single host than is the case with the entoparasites, but usually one egg only is delivered. The females may return to the host after oviposition, but leave it again after a preliminary probing with the ovipositor. Edwards (1955) and Narayanan and Chaudhuri (1954) suggested that ectoparasitic species *Stenobracon deesae* and *Mormoniella vitripennis* recognize the host by means of the ovipositor, but the sense used to avoid superparasitism is unknown. Pumphrey (1950) suggests that the hearing is of some importance. Probably there are several stimuli, the receptors may be chemotactile, olfactory and auditory (Lloyd 1956).

The fact must be established, that all the species succeeded in oviposition during the present experiments have the possibility to distinguish between parasitized and unparasitized hosts. Superparasitism seems to occur if parasitized hosts only are accessible for the female. The field material of *Phyllocnistis labyrinthella* supports this. The number of eggs at each host is one. Twice only two eggs on the same host larva were observed. In the second generation of *Phyllocnistis suffusella* on the other hand, a time with few accessible hosts, several eggs at each larva have been observed. According to Lloyd (1938), the female tends to retain the eggs rather than deposit them during the condition described. Nothing similar has been observed in connection with the present material.

The senses used to avoid the superparasitism have not been investigated, and it is difficult from the present material to appraise earlier theories.

Competition

Competition may be defined as the demand at the same time by more than one organism for the same resources of the environment in excess of immediate supply (Crombie 1947). As mentioned, one parasite only of the present examined species has the posibility to carry through the development at each host specimen. The superparasitism, observed in the present material may consequently result in competition. The eggs deposited in or at the host hatch nearly always, and the small larvae are found side by side, until the host is consumed. Proper (1931) indicates that starvation is the cause of the death of nomaturing individuals, and this assumption agrees with the present observation. The bigger larva attack the smaller as soon as the host is consumed, and at last one parasitic larva only remains. Competition is found to be usual owing other species also (Blunck 1952).

During the experiments, multiple parasitism has occurred. The ectoparasites happen to deposit eggs at larvae earlier oviposited by an entoparasitic female. Here too, the larvae develop side by side until the host is empty. In all the tested cases the entoparasitic larva is the victor. The ectoparasitic larva is consumed completely. The competition as a consequence of superparasitism may have some importance for the increasing rate of the parasitic species, multiple parasitism some importance to the interspecific competition. In the present abundance of the moth *Phyllocnistis labyrinthella* competition seems to have little influence on the efficiency of the parasites.

The relation between the parasites and the hosts

The avoidance of the hosts

With the hosts of the examined parasitic species there is a marked difference in the structure of the mine as well as the response to the parasitic attack. The larvae of the hosts are of different size, and mine in various tissues of the leaves. *Phyllocnistis* causes a feeding channel in the epidermis only, a mine relatively broad, but with a limited vertical extension. The larva has little chance of movements. At the attack of the parasitic female, the larva merely stops feeding, and offers no resistance. The larva remains quiet until the feeding or the oviposition of the entoparasites are completed, then it turns back to the mining activity.

The larvae of *Lyonetia clerckella* make the feeding channel in the pallisade- and spongy-tissue narrower in proportion to the breadth of the larva compared to the moth *Phyllocnistis*, but the depth is greater. This larva seems to have a greater power of movements than the first mentioned, and at the moment of the parasitic attack, the larva of *Lyonetia* moves forward and backward in the mine. The smaller species of the parasites seem to become afraid at the larger host's resistance. They leave the latter without any oviposition. The larvae of *Lyonetia* are frequently killed by the parasites during the feeding period, contrary to *Phyllocnistis*.

The feeding channel of the weevil *Rhynchaenus* is as mentioned a blotch mine in the pallisade-tissue mainly, with ample opportunity for the larva to move. At the parasitic attack the larva nearly runs from side to side, and it usually takes a long time for the female to feed on, or to «paralyse» these hosts. A female of *Cirrospilus pictus* was observed in continuous attack of a weevil larva without any result during a period of 2 hours.

The different depth of the leaves which remains over the larvae seems of no consequence to the oviposition. The size of the larvae and the possibility for movement are more important. During the laboratory experiments it has been difficult to get the smaller species to oviposit in or at the last stage larvae of *Lyonetia* and *Rhynchaenus*. In the field material the same parasitic females were found to attack these hosts at an earlier stage of development.

The conclusion is that the moth *Phyllocnistis labyrinthella* causes the least resistance against the attack from the parasitic females. The pupa only of this moth has the possibility to avoid the parasite. *Lyonetia* and *Rhynchaenus* make greater resistance against the attack, and the different parasitic species will oviposit at the different developing stages of the host.

The efficiency of the parasites

Before and during the oviposition period the parasitic females attack the host larvae for feeding as mentioned. Consequently one should expect the number of larvae destroyed to exceed the number of eggs placed. The oviposition period may last about 40 days (laboratory experiments), and all this time feeding takes place. But as pointed out, the host *Phyllocnistis labyrinthella* are not killed by this attack. The larvae most frequently continue the mining activity as soon as the parasite leaves the host. Only small larvae happen to die during the parasitic feeding act.

Sometimes unviable eggs are deposited. The entoparasitic eggs remains in the host, as a black or brown body. The ectoparasitic females sometimes fail in «paralysing» the host. The latter continues the mining activity after the ovipositing, and the egg remains alone in the mine. As to the field material, dead parasitic eggs in the pupa of *Phyllocnistis labyrinthella* are sometimes found, and also ectoparasitic eggs in the mine, leaved by the host. This verifies existence in the field of the circumstances mentioned, but the importance for the multiplication of the parasitic species is difficult to determine.

In 1953 the efficiency of three of the parasitic wasps was measured during the laboratory experiments. It was the entoparasitic wasp *Epilampsis tadici*, and the ectoparasites *Cirrospilus vittatus* and *Eulophus pectinicornis*. The results were:

Tab. 1. *Number of attacked and killed host larvae and the death rate during the developing period for three of the parasitic species.*

	Per cent of killed larvae	Number of larvae attacked	Per cent of eggs developed to imago	Number of eggs placed
Epilampsis tadici .	72	174	20	295
Cirrospilus vittatus	79	211	35	337
Eulophus pectinicornis	92	86	54	100

Neither the rate nor the cause of death during the larval stages of the parasites have been determined, but are supposed to be nearly the same for the three species. The developing has occurred under the same conditions. The host was *Phyllocnistis suffusella*. As the table shows, the species *Eulophus pectinicornis* seems to be more efficient than the other species, with a higher ratio of the attacked larvae killed, and a larger number of the eggs developed to maturity. *Epilampsis tadici* seems to be the least efficient parasite of the three examined species. Consequently, one should expect *Eulophus pectinicornis* to be the most common in the field. But that is not the case. However, the experiments point out that the parasites do not kill the total number of attacked hosts.

The frequency of the parasites

After the hibernation, the moth *Phyllocnistis labyrinthella* turns up in the field in the last half of April. The parasites on the other hand appear when the host is in the third larval stage. No trace is observed earlier. These parasites attack the larvae for feeding before and during the oviposition period. The feeding stings remain as small black spots on the larval cuticle. Likewise the oviposition discloses the appearance of the parasites. In the territory of Oslo, the first parasites for instance were caught one year in the field on June 6th, and the first track observed nearly at the same time. On the other hand it is difficult to get any idea of the number of the active parasites at this time.

The frequency of the parasites on *Phyllocnistis labyrinthella* is controlled later in the season. The number of moths and the parasites from the different stations is counted after the emergence of the animals. As to the moth, the pupa emancipate itself from the pocket by means of the cocoon piercer. By means of a little slit in the cuticle of the leaf, the pupa escapes. After the emergence, the pupa covering case remains in the leaf (fig. 29), or comes down. The parasites on the other side emerge within the leaf, and the wasp makes its way out of the pocket. It gnaws a little round aperture in the cuticle, through which it escapes (fig. 30). In both cases it is possible to determine if the pocket has been inhabited by a moth or a parasite. The size of the hole in the cuticle differs with the size of the parasite. A female of *Epilampsis tadici* for instance may make a hole of 0.5 × 0.6 mm.

The parasitic frequency expressed as the percentage of all the animals emerged is illustrated in figures 16–18. The whole collected material is found in tables 12–14. As with the attack, great variation is found in the parasitation in the different samples within the same territories, as well as in the different years. But the fluctuations are smaller compared with the population of the moth. In the area around Oslo the parasitation varies between 2.6% and 40.4 %. In Telemark a rise in the parasitic frequency is observed near the limits of the pest attack. An increase from 7.7 % to 43.9 % along the head line is shown. Nearly the same rise in the parasitic curve is found from year to year. In this area, the highest observed parasitic frequency

(54.4 %) is registered. The greatest fluctuations in the number of parasites are found near the limit of the pest attack.

According to Burnett (1953), a higher temperature gives a higher parasitic frequency. The mean temperature in Trøndelag is found to be lower than in Telemark. In accordance with this, the parasites are found to be more scarce in Trøndelag than in the area in Telemark.

In the different years, parasitation shows little variation. In spite of the great number of host larvae no marked increase is found in the parasites' number. The first investigation year the parasitation was more moderate than later, but no continuous increase from year to year is indicated.

No difference in number is found in the territory with and without attack of *Lyonetia clerckella*. Last year (1956), the parasites were fewer in number than the year before. The parasitic frequency was low in the different examined territories compared with the number of moth. In a few samples only the parasites appear in a number equal to the moth. In spite of a great number of host larvae, no increase is found in the frequency of the parasites. From year to year the parasitic population fluctuates only little. In the limit zone only a greater fluctuation is observed.

The parasitic species in the different territories

As mentioned, 14 parasitic species on the moth *Phyllocnistis labyrinthella* were observed during the present investigation. The distribution of these species is seen in figures 34–47. The number of specimen emerged from the different samples is found in table 15–17.

Little difference is found in the composition of the species in the compared areas. *Cirrospilus vittatus*, *Cirrospilus pictus*, *Eulophus pectinicornis*, *Eulophus longulus*, *Eulophus straminiepes*, *Sympiesis sericeicornis*, *Epilampsis tadici*, *Closterocerus trifasciatus* and *Tetrastichus femoralis* have emerged from all areas. In Oslo and Telemark the species *Cirrospilus elegantissimus* and *Epilampsis mirabilis* are added to the list. In Telemark and Trøndelag the species *Epilampsis gunholdi* have been observed, while *Cirrospilus subviolaceus* and *Tetrastichus xanthops* are found in Telemark only.

The frequency of the different species varies considerably, however. *Epilampsis tadici* is the most common species in all territories, only in Trøndelag the last year (1956) was it more scarce. Usually it represents more than half of all the specimen emerged. In Telemark this species appeared one year (1955) in a number of 551, the total number of parasites was 1061. *Cirrospilus vittatus* and *Cirrospilus pictus* are common species, with a more frequent occurrense in Telemark and Oslo than in Trøndelag. The genus *Eulophus* has a quite different distribution. *Eulophus pectinicornis,* the most usual species within this genus, composes about 16.5 % of all the parasites emerged in Trøndelag. In Oslo and Telemark the ratios are respectively 6 % and 1.7 %. *Eulophus longulus* is mainly observed in Trøndelag. These two species of the genus *Eulophus* were found as parasites on *Lyonetia clerckella.* As mentioned earlier this leaf-mining moth has a common occurrence in Trøndelag. It is worth noting that these species appear most frequently in the territory with the attack of *Lyonetia clerckella.*

As to the different years, the species *Epilampsis tadici* was more scarce in Trøndelag the last investigated year, while the population of *Tetrastichus femoralis* has increased. In 1955 this species constituted 12.9 % of the parasitic population.

The proportion between the emerged females and males is much larger than one. As to the most numerous species, *Epilampsis tadici,* the males may constitute one fourth of the emerged females. The number of specimen of the different species within the same territory is observed to be somewhat variable. According to Crombie (1945), two kinds of organism will be able to survive together only if they occupy different ecological niches. Later Crombie states (1947) that related species which occur in the same area will tend to complete if the ratio of population to resources is high enough. The laboratory experiments have shown the parasitic species during the developing period to have almost the same needs and habits. The population density of the different parasitic species, however, is found to be low. In the present material, the interspecific competition is of little importance, a theory supported by the small fluctuations within the different species.

The proportion between the different species in the examined territories on the other hand, varies considerably. A few species are found in some of the territories only. This does not necessarily mean that the species are unable to survive in the undiscovered territories, possibly the wasps have not yet reached the areas. The more numerous appearance of some of the parasitic species in one area than in the other may be explained by the above. But the difference is more probably due to difference in need between the species. The present investigation has controlled the developing period only. Difference may exist in other periods of the life cycle.

The succession of the emergence of the different species

As previously mentioned, the emergence of the moth *Phyllocnistis labyrinthella* occurs in July. The same is observed as to the parasites. In the field as in the laboratory the moth escape somewhat earlier than the wasps. In material collected on July 5th (1955), the first moths escaped on July 8th, the first parasites on July 10th. The emergence continued to July 24th, i. e. about 2 weeks.

As to the succession of the different species, there seems to be no clear sequence. The different species emerge inter-mixed, but the bulk of the species may appear at different times. Table 18 shows the number of animals from the samples from Trøndelag 1955, escaped the different days. The ectoparasites appear before the bulk of the entoparasites. The first three days of the emergence period a few parasites only issued. The status of the eight first days shows that about 1/2 of the species *Cirrospilus vittatus* escaped, about 3/4 of the species *Cirrospilus pictus*, about 1/2 of *Eulophus pectinicornis*, and *Eulophus longulus*, 3/5 of *Eulophus straminiepes*, 1/2 of *Sympiesis sericeicornis*, 1/4 of *Epilampsis tadici* and about 1/3 of *Tetrastichus femoralis*. Less than a half of the parasites emerged in the course of the first 8 days.

The entoparasite *Closterocerus trifasciatus* was observed to escape the last days of the emerging period.

The same species are emerged from samples collected in the same area at different times, even with an interval of 14 days. The material from Trøndelag 1954 is seen in table 2.

Tab. 2. *Number of parasites emerged from samples collected at different time.*

	Samples collected on					
	June 25			July 9		
	♀	♂	total	♀	♂	total
Cirrospilus vittatus	9	3	12	6	6	12
Cirrospilus pictus	25	12	37	6	1	7
Eulophus pectinicornis	16	2	18	28	2	30
Eulophus longulus	4	4	8	25	30	55
Eulophus straminiepes	12	9	21	18	26	44
Sympiesis sericeicornis	2	1	3	—	1	1
Epilampsis tadici	179	169	348	116	16	132
Epilampsis gunholdi	4	0	4	2	—	2
Closterocerus trifasciatus	—	—	—	1	—	1
Tetrastichus femoralis	4	6	10	1	9	10
	255	206	461	203	91	294

The greatest number of parasites is emerged from the earliest collected samples, but the material is not guaranteed to be equal in size, and no importance must be attached to this difference. No emergence was observed before the collection of the material. In the laboratory the parasites started to issue nearly simultaneously from the different samples.

The proportion between the different species varies. The species *Cirrospilus pictus* and *Epilampsis tadici* are most numerous in the material collected on June 25th. In the samples from July 9th. the greater part of the genus *Eulophus* is issued. The examination of the biology of the present species shows, as previously mentioned, little difference in the duration of the development of the wasps. The average figure for *Cirrospilus pictus* was 15½ days, for *Eulophus pectinicornis* 17 days, and *Epilampsis tadici* 17 days. This indicates that the parasitation by the different species occurs at different times. The main attack of the species *Cirrospilus pictus* and *Epilampsis tadici* appears from the present material to happen earlier than the attack of the genus *Eulophus*. Likewise, the parasitation of *Phyllocnistis labyrinthella* is possibly about 14 days previous to the emergence of the moth.

The parasites on Phyllocnistis labyrinthella from areas without any «attack»

The parasitic species previously mentioned originate from material collected in territories with heavy attack of *Phyllocnistis labyrinthella*. The extension of this attack (fig. 33), is independent of the distribution of *Populus tremula*. In the areas outside the limits of the attack the moth is present, but the population density is low, attacked leaves are rare. In these territories the conditions for the increase of the moth's population must differ from those in the attacked areas. In connection with the present investigation, it is inevitable to wonder about the parasites in the unattacked areas, whether for instance there are other species than those already observed.

The collection of the material for this investigation necessitated an implantation of moths in an area without any attack. A territory in the south of Norway, (Nelaug) about 70 km from the examined area in Telemark was chosen. Here about 2700 moths were free in 1953. The animals for the implantation were caught in the territory around Oslo.

The last days before and during the oviposition period the moth is found in multitudes on the trunk of aspens, and may be caught easily. The moths were collected shortly before the oviposition. The sex ratio was kept as near one as possible. The condition for a successful experiment is that the leaves of the aspen in the implanted territory must be of nearly the same phase of development as in the area of the collection. The first year the area chosen had aspens in different phases, but all over the trees were later in development comparable with the territory of Oslo.

The moths escaped on May 13th, and the oviposition started the same day, only a few hours after the slipping.

This territory was not controlled till the last days of June. A small rise in the number of the attacked leaves was found, but on the whole it seemed as if the oviposition had failed.

The same experiment was carried through in 1954. This year about 2500 moths were collected. The moths were caught on May 15th and escaped on May 16th. At this time the aspens in the territory of the earlier experiment had only buds, and the animals this year were set free 6–7 km north of Arendal, about 25 km south of the first place. Here the leaves were sprouting, making oviposition possible. The vegetation of the two places was practically the same. The condition of the animals was about the same as the year before, but the time between the collection and implantation was shorter. This year the experiment resulted in more attacked leaves.

The parasitic material from these areas is seen in table 19. The first year (1953) 20 wasps only emerged, while a considerable increase was found the second year. 10 different species are represented, all known from other territories. The most usual species are the same as found in other areas.

The number of attacked leaves is low and consequently leaves attacked on both sides are rare. In 1956 2.4 % only of the devastated leaves was of the latter category. The result of the count:

Arendal:	Leaves	attacked	24.4%	(50 leaves)
	»	unattacked ..	75.6%	(155 »)
Nelaug I:	»	attacked	7.1%	(12 »)
	»	unattacked ..	92.9%	(156 »)
Nelaug II:	»	attacked	21.8%	(22 »)
	»	unattacked ..	78.2%	(79 »)

The ratio between the number of moths and parasites emerged 1956 is seen in table 3.

The investigation shows the presence of the same parasitic species in the «unattacked» as in the great devastation territories. Not one new species has been observed as parasite on *Phyllocnistis labyrinthella* in the lately examined area. Samples from

Tab. 3. *The frequency of the parasites expressed by per cent emerged moth and parasites. Nelaug–Arendal.*

	Number of animals	Moths	Parasites
Nelaug I	106	50.9 %	49.1 %
Nelaug II	125	51.2 %	48.8 %
Nelaug III	114	60.4 %	39.6 %
Arendal I	107	49.5 %	50.5 %
Arendal II	87	62.1 %	37.9 %

other territories with scarce attack by *Phyllocnistis* show that the same *Hymenoptera* species parasite the moth.

Compared with the other territories, the frequency of the parasites is great in the «unattacked» area. The data are inadequate but show the difference compared with the great attacked territories. The number of emerged moth and parasites is nearly equal. In the previously examined territories, a parasitic frequency of the same size is found in Telemark only, and toward the limit zone. The implantation of the moth could be expected to give rise to a high population level in the new area. It is too early to be quite sure about the consequence of the implantations, but the examinations during the following years give no indication of any attack.

The death-rate of the moth's third larval stage in different territories

According to earlier investigation (Sundby 1953) the death-rate in the last developing stages of *Phyllocnistis labyrinthella* is low in the territory around Oslo, that is a territory where the pest attack has been nearly unvariable the last years. In the areas with decreasing (Telemark) and diminutive attack (Nelaug, Arendal) a greater part of the population is destroyed in the third larval stage. As for the supposition that the death rate is equal in the different territories, the counted and estimated number of dead larvae are as found in table 4.

As seen, the death-rate in the mentioned stage and territories is two to three times the death-rate in heavily attacked territories. The greatest part of these larvae show trace of parasitic attack, and many of them are found to be host for a parasitic larva. In the same material, hosts of a length of 2.5 mm were attacked by the parasites.

This indicates an earlier parasitic attack of the moth in the territories with diminutive than with heavy population of *Phyllocnistis labyrinthella.*

Tab. 4. *The number of counted and calculated dead larvae in the territories of Telemark and Nelaug–Arendal. The estimated number correspond the death rate in the territory of Oslo.*

	Number of pupae	Counted dead larvae	Estimated number of dead larvae
1954			
Telemark 39	114	174	56
— 40	137	146	68
— 41	120	125	59
1956			
Telemark 39	49	142	24
— 40	119	118	59
1954			
Nelaug I	132	190	65
— II	60	94	30
Arendal I	100	75	49
— II	206	128	101
1956			
Nelaug I	139	238	69
— II	129	97	64
Arendal I	127	118	62
— II	92	90	45

Changing of host

Field observations

As mentioned, the moth *Phyllocnistis labyrinthella* has only one full generation a year, the parasites on the other hand usually two. The laboratory as well as the field examinations support this theory. The few second generation larvae of *Phyllocnistis labyrinthella* are therefore in strong demand by the parasites. The superparasitism as well as multiple parasitism are usually observed at this «generation».

Consequently, the second generation of the parasites must develop on other insects. As earlier mentioned, the parasitic species of *Phyllocnistis labyrinthella* are previously emerged from different hosts. The question is whether other hosts are present, and secondly if these are employed. *Lyonetia clerckella* is the only present host earlier mentioned. In addition the parasites are emerged from the leaf-miners *Phyllocnistis suffusella* and *Rhynchaenus populi*. The biology and the distribution of these hosts have been described earlier.

Eight of the species emerged from *Phyllocnistis labyrinthella* are observed as parasites on one or more of these leaf-miners. *Epilampsis boops* only is found in addition to the species earlier known. Different hosts are present in the examined territories, and the same parasitic species develop on different hosts. The question is if a parasitic wasp is ready to oviposit on another host species than where the imago is developed. The mentioned experiments will give the answer.

Laboratory experiments

In the laboratory, efforts were made to have the females of different parasitic species oviposit in or beside different hosts. The females used are emerged from different species. The experimental conditions have been the same as during the oviposition test mentioned earlier. The results of these experiments are given in table 20.

During the experiments, the females emerged from *Phyllocnistis labyrinthella* have nearly always succeeded in oviposition on the same host. The attacks usually occur shortly after the admittance to the larvae. As to other leaf-miners, feeding and oviposition take place, but often a longer time passes between the admittance and the attack than is usual for *Phyllocnistis labyrinthella.*

The animals emerged from *Lyonetia clerckella* oviposit the same host as well as other leaf-miners. *Phyllocnistis labyrinthella* often seems to be preferred, but after an oviposition period on *Lyonetia clerckella,* the wasps have happened to neglect the host *Phyllocnistis.*

The few specimen issued from *Rhynchaenus populi* have succeeded in oviposition on *Phyllocnistis labyrinthella* and *Rhynchaenus.*

This indicates that the parasitic wasps are free from the host where they are developed. The oviposition has occurred, and the progenies are full-grown on other leaf-miners. The oviposition is most easily obtained on *Phyllocnistis labyrinthella.* Among other hosts, the females prefer the species from which they are emerged. As already mentioned, the host developing stage is important for the suitability of the host.

The larvae of *Lyonetia* is most frequently attacked by *Eulophus longulus,* the larvae of *Rhynchaenus* of the wasp *Cirrospilus pictus. Eulophus longulus* are the most frequent parasite on *Lyonetia clerckella* in the field material. The same condition is observed with *Cirrospilus pictus* and *Rhynchaenus.*

During the experiments, parasitic species have succeeded to parasitize host different from field observation (*Eulophus* – *Rhynchaenus*).

The experiments show that the parasites emerged from *Phyllocnistis labyrinthella* may change host from one generation to the next. According to the mining time for the different hosts, few chances of host changing seem to be present.

As mentioned previously, the species *Lyonetia clerckella* in the south of Norway make only a rare appearance. It is difficult to determine the occurrance of host-changing in the field, but some importance is supposed. The mining larvae of *Rhynchaenus* are observed after the emergence of the parasites in July, but the laboratory experiments show that the female avoids the bigger larvae of this weevil. In addition, this host has only one generation a year, and a sporadic appearance. The importance for changing of host seems diminutive.

In Trøndelag the single generation of *Lyonetia* makes difficulties for the host changing. A few days only this host elongates the oviposition period for the parasites.

As previously mentioned, the genus *Eulophus* is more usual in Trøndelag than the other examined territories. The smaller species of the parasites avoid the full-grown larva of *Lyonetia*, *Eulophus* only attack this larval stage. This indicates a change of host to take place for the species of the genus *Eulophus*. The other parasitic genera have no change for oviposition on *Phyllocnistis*. The number of generations of *Lyonetia* gave a result opposite that expected.

Discussion

The main objectives of the present work were to clarify the parasitic conditions of the leaf-mining moth *Phyllocnistis labyrinthella* during the present heavy attack.

The investigation shows the presence of different parasitic species, but the number of specimen is low. The parasitic frequency varies between 2 % and 54 % in the different territories. (The estimate refers to the emerged animals). According to De Bach and Smith (1941), a parasite must be able to destroy a greater part of a population when it is dense that when it is scarce, if a regulation effect shall be obtained. The number of parasites in the present work increases slightly toward the limits of the attack, but the parasitic frequency and the limits are not markedly different from year to year. The parasites mentioned seem to have no or little «regulation effects».

In view of the abundance of the host material, an enormous increase in the parasitic frequency would be expected. Why did it not happen? Of what kind are the resources of parasites?

The parasitic frequency depends on several conditions. First, the host must be present, and the parasitic females must possess efficient host-searching organisms. They must have the power of locomotion, the power to utilize the ovipositor and to deposit the egg (Flanders 1947). The present parasitic species have these attributes. During the experiments they always succeeded in finding the host. The time they spend on host-finding in the field is not observed, but the experiments show them efficient host-searching organisms and the density of the host only facilitates the detection. The deposition of the eggs causes no trouble.

The species have the possibility to distinguish between parasitized and unparasitized hosts. In the ectoparasitic species the «paralysing» occurs immediately before oviposition. Contrary to other species (Ullyett 1949–50) the female remains at the host until the egg is delivered. A relocating of the host is thus avoided, which means a greater efficiency of the parasites.

Superparasitism and multiple parasitism are observed in the laboratory as well as in the field, but are rare in the field material, and consequently give little evidence for the parasitic frequency. The host density reduces the probability of more eggs at each host. The superparasitism seems to occur only when there are few possibilities to deposit the eggs.

According to Nicholson (1954 b) the mechanism of density governance is nearly always intraspecific competition. The low population density of the parasites in the present investigation could be expected due to the intraspecific competition. From year to year the same parasitic species are observed in the different territories, the abundance however, differs. Each single species is subjected to small fluctuations. No steady state is obtained as found in other species (Utida 1953). As mentioned previously, Crombie (1947) states that related species which occur in the same area will tend to compete if the ratio of population to recourses is high enough. The present investigation established the ratio between the parasitic population's density and the host to be low. The presence of intraspecific competition cannot be denied, but according to the food supply, the parasites have the possibility to increase to a higher density than today observed.

The efficiency of a parasite depends on the number of generations as well. The species in the present investigation have consequently one generation a year on the main host, but the possibility of two generations in a single season is present. The experiments show the females willing to change the host. The presence of hosts for the second generation in the different territories is as mentioned scarce. The composition of the parasitic species in the territories, shows great difference. The genera *Cirrospilus* and *Epilampsis* are most usual in all territories. The species of *Eulophus* are more numerous in Trøndelag than in the other areas. The latter is found as a frequent parasite on the moth *Lyonetia clerckella* in the same territory. The experiments show the species of this genus able to attack the greater larvae of *Lyonetia clerckella* and larvae of this moth are detected after the pupation of *Phyllocnistis*. This seems to indicate host changing, but as mentioned, *Lyonetia* too has only one generation a year in Trøndelag. Other hosts than those observed may be used for the second generation, but today the parasites emerged in July seem to have few chances for egg deposition the same year. If no other hosts are detected, the females cannot oviposit until the next spring. According to Graham and Prebble (1953) a long separation of the parasites and their hosts seems to limit parasite effectiveness seriously. This seems to be of importance for the present problems.

The attributes discussed suggest the waps to have the possibility of effective parasites. Several authors indicate the importance of the time factor in biological control. Clausen (1951) claims that a parasite can produce full control within a period of 3 generations or 3 years. Thompson (1951) likewise calls attention to the importance of the time in the parasitic control, but takes some reservations as to the theory of Clausen. The latter is supported by the works of Sellers (1953). In the present material, parasites are found during a longer time than that supposed to produce full control. No essential change may be expected in future.

The greatest number of eggs placed by a single female during the experiments is 58. The total possible number seems to be of the same size. The oviposition period lasts under the same conditions as long as 40 days (maximum). The greatest number of eggs a day is found to be 8. But no female is observed to place such a number every day. Two to three eggs are most usually deposited. As mentioned, the egg production proceeds during the whole oviposition period at the present parasitic species, and the females need a certain time for the ovulation. Possibly the wasps are able to deposit the total number of eggs during a shorter time in the field than that found in the laboratory, but the number of experiments and the number of eggs a day indicate the observed oviposition period to be fairly accurate.

The time of the wasps' appearance in the heavily attacked territories is at the last days of the moth's third larval stage. No trace is observed earlier, neither as an attack of the larvae nor during the attempts of catching. The emergence of the parasites in the laboratory lasts about 14 days, the development of the same species between 17 and 20 days, this at a temperature of 22° C. The pupation period of *Phyllocnistis labyrinthella* is 35 days (Sundby 1953). In other words, the parasitic females must deposit the eggs several days before the moth emerges. The material from Trøndelag 1954 supports this theory. The emergence of the parasites from samples collected at different times started as mentioned nearly simultaneously. The parasitic eggs are placed at least 14 days before the moth's emergence. This gives the wasps' females an oviposition period of about 25 days, i. e. a shorter time than that measured in the laboratory for the deposition of the total number of eggs.

In the territories without any attack, a greater proportion of the host is destroyed by the parasites in the last larval stage. The total observations indicate that parasitic females have too short a time for the oviposition in the territories with great attack, contrary to the areas without devastation. The active female seems to escape hibernation too late to utilize its potential resources.

The investigation has shown the present parasites to have the possibility of being effective, but that they are unable to develop these traits. This are supposed due to the number of host's generation, the scarcity of parasite's second generation hosts, and the short oviposition period by the host *Phyllocnistis labyrinthella*. The ultimate causes are possibly due to microclimatic conditions, but probably caused by more factors.

Summary

The present work deals with the parasites on the leaf-mining moth *Phyllocnistis labyrinthella*, the biology of the different species, and the relation between the parasites and their hosts.

14 different species are emerged from *Phyllocnistis labyrinthella*. The genera *Cirrospilus*, *Eulophus* and *Tetrastichus* compose the ectoparasitic species, the genera *Epilampsis* and *Closterocerus* the entoparasites. *Sympiesis* has failed in oviposition experiments. The duration of the development, at a temperature of 22° C ± 1° C, is found to be about 17 days, with some variation between the different species. The shape of the larvae and the mandibles, and the number of the spiracles in the last instar are presented for the different species.

In the field one generation a year has been observed, but the investigation shows the possibility of two generations a year.

In addition to the main host, the parasitic species are emerged from the moths *Phyllocnistis suffusella* and *Lyonetia clerckella*, and the weevil *Rhynchaenus populi*. All the hosts are leaf-miners.

The behaviour of the parasites is found to be somewhat similar to other parasitic species. Mating is observed to take place only once. Hostfeeding occurs before and during the oviposition period. The egg-production is in progress during the whole oviposition period. An individual host can afford sustenance to only one parasitic larva. Usually one egg is deposited at each host, but superparasitism and multiple parasitism are observed.

Consequently, competition is shown. The ectoparasitic species as well as the entoparasites have the ability to distinguish between parasitized and unparasitized hosts. The ectoparasites «paralyse» the hosts before oviposition. No difficulties are observed as regards deposition of the eggs at the host *Phyllocnistis labyrinthella*. The other hosts make greater resistance against the parasitic attack, and the earlier stages of development are preferred for oviposition for the smaller parasitic species.

The examination of the population density of the moth *Phyllocnistis* and the parasites was carried out in three different territories. The population of *Phyllocnistis* is nearly saturated in some areas with a number of about 95 % of the aspen's leaves being attacked on both sides, but with great variation in size. The population density decreases quickly toward the limit of the pest attack.

The frequency of the parasites varies between about 2 and 50 per cent, but is low all over. Little variation is observed from year to year, only with an increase toward the limit of the attack. Nothing indicates an increase of the parasitic frequency in the future.

The implantation of the moth in unattacked territories has shown the presence of the same parasitic species in the areas without any attack as in the heavily attacked territories.

The death rate in the third larval stage is greatly different in the attacked and unattacked areas. The investigation indicates that parasitic females have a longer time for oviposition in the unattacked territories. In the territories with heavy attack, the females have too short a time for deposition of the egg compared with the oviposition time measured in the laboratory.

The same female oviposits hosts of different species. A changing of host should be possible in the field, but few other hosts are detected. The low parasitic frequency is supposed to be due to the short oviposition period in the first generation, and the scarcity of hosts for the second generation.

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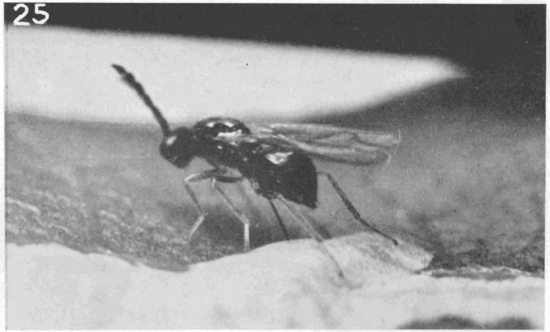

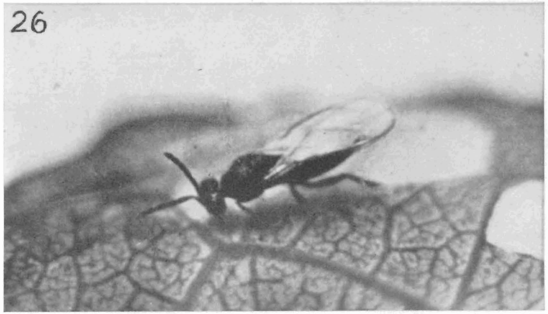

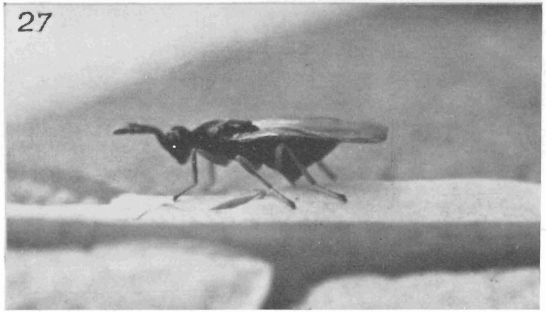

Fig. 24. A female of *Eulophus pectinicornis* in host searching.
Fig. 25. The inserting of the ovipositor.
Fig. 26. The imbibing of the host's blood.
Fig. 27. Egg deposition. A female of *Cirrospilus pictus*.

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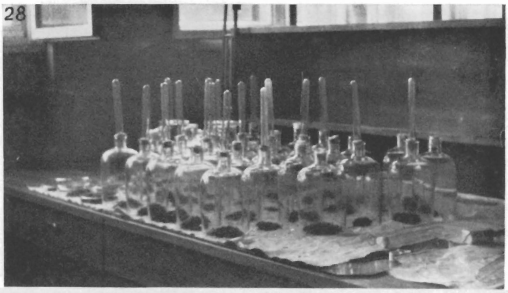

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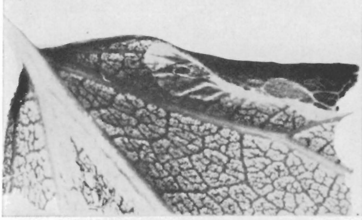

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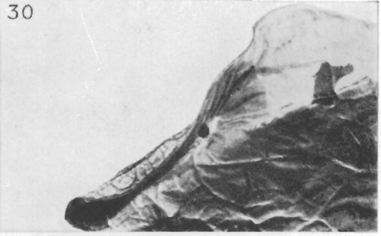

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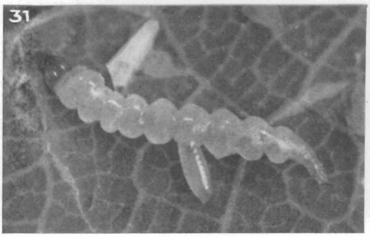

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Fig. 28. The bottles used for the emergence of the animals.
Fig. 29. A leaf of *Populus tremula* with an empty pupa of *Phyllocnistis labyrinthella*.
Fig. 30. The aperture in the cuticle through which a parasite has escaped.
Fig. 31. A newly hatched parasitic larva. The host is still light.
Fig. 32. An ectoparasitic larva which nearly has consumed the host. The latter brown.

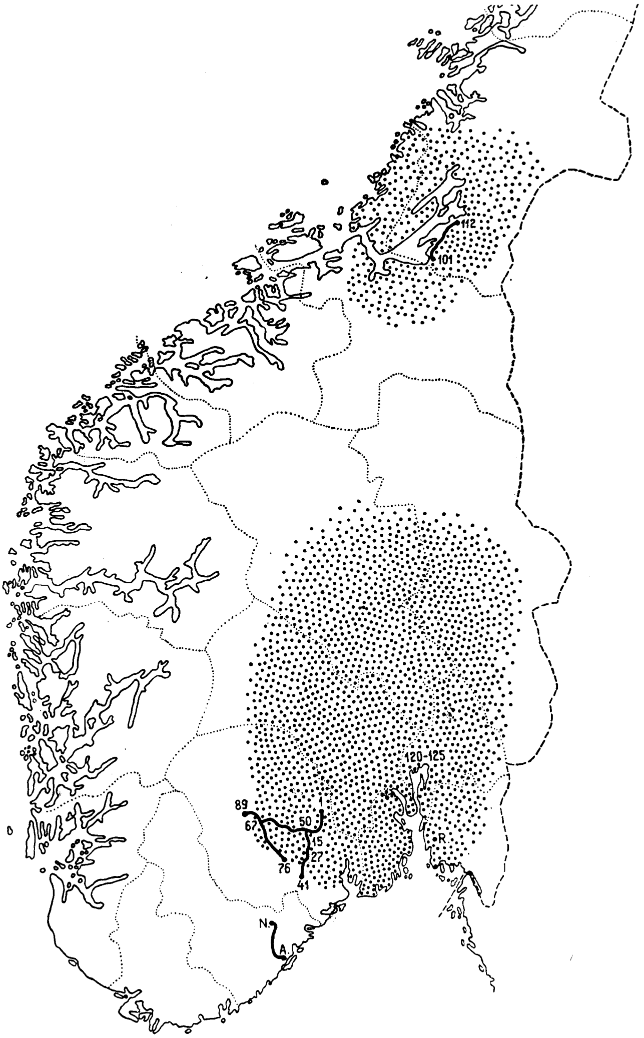

Fig. 33. The distribution of *Phyllocnistis labyrinthella*. Locations of stations. A: Arendal. N: Nelaug. R: Råde.

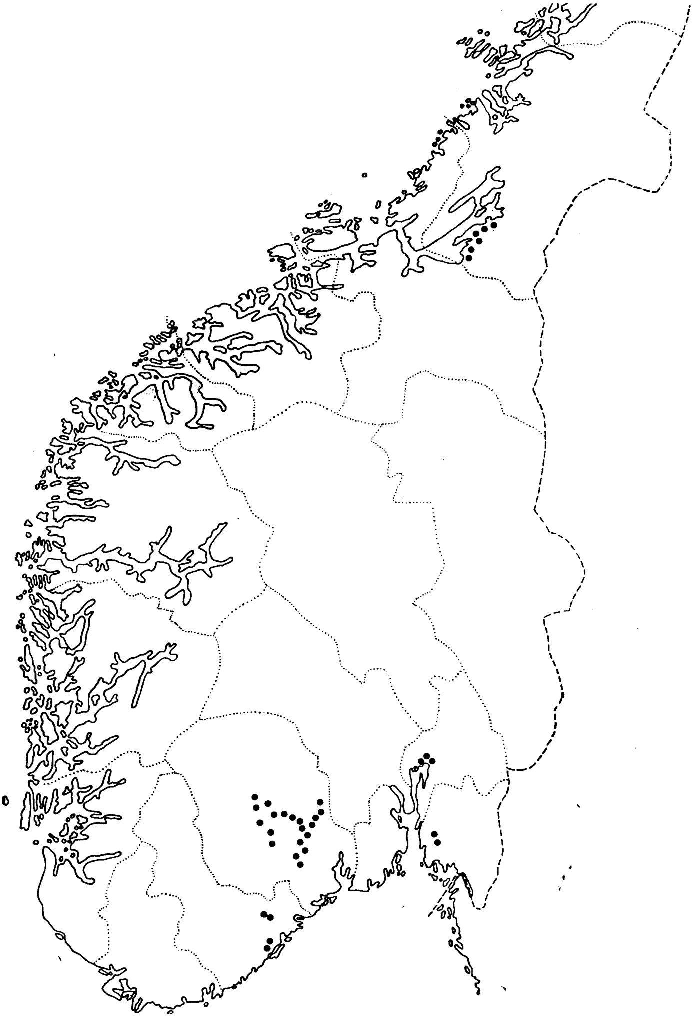

Fig. 34. The distribution of
Cirrospilus vittatus in the examined territories.

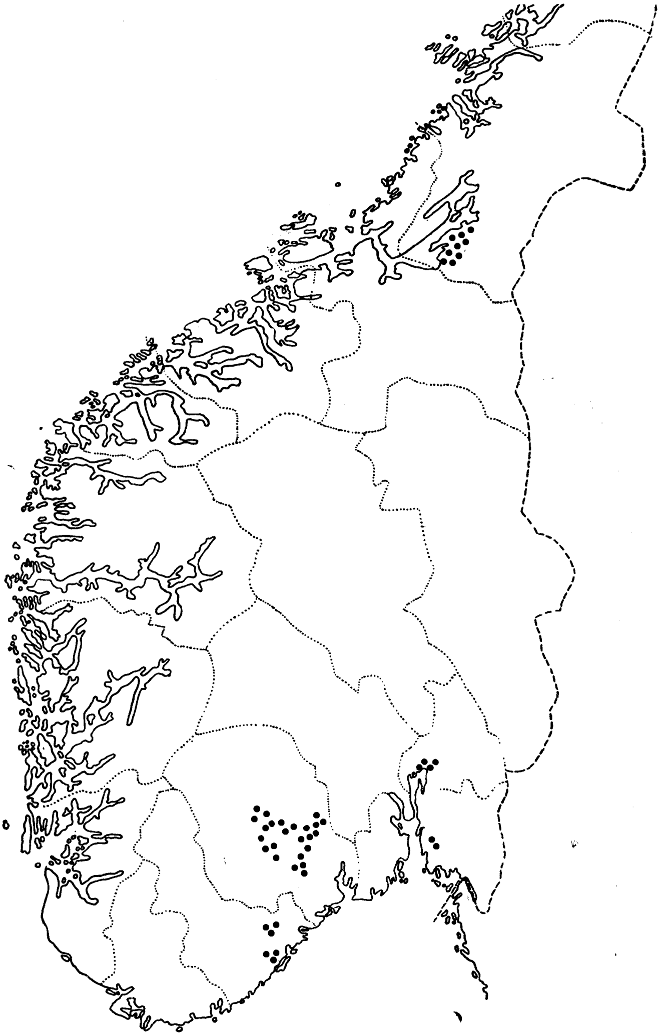

Fig. 35. The distribution of *Cirrospilus pictus* in the examined territories.

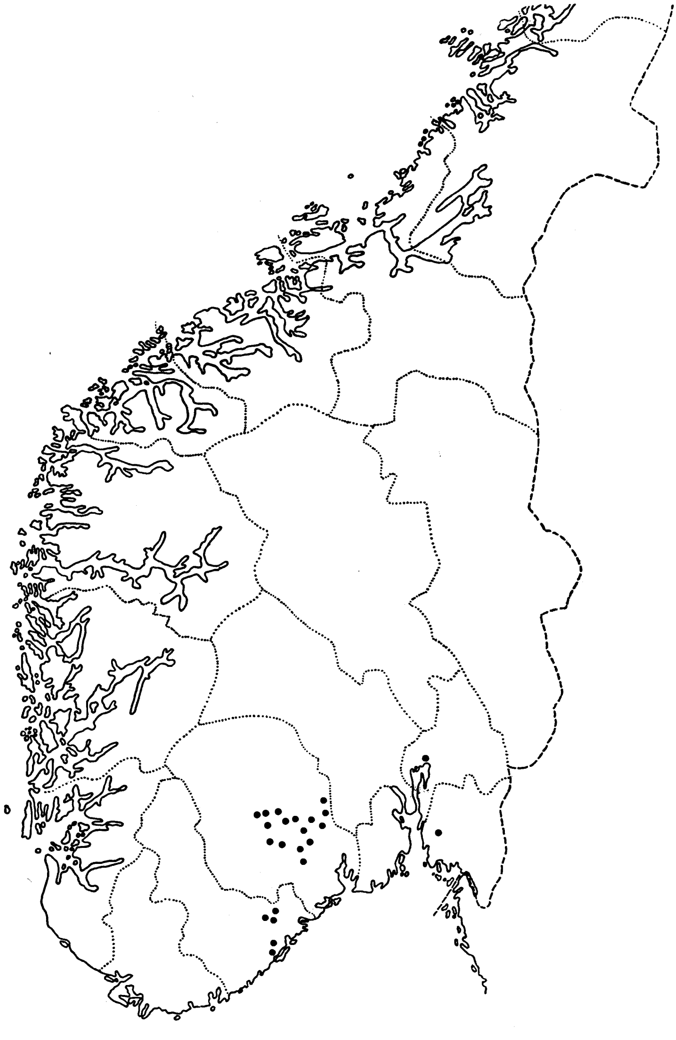

Fig. 36. The distribution of
Cirrospilus elegantissimus in the examined territories.

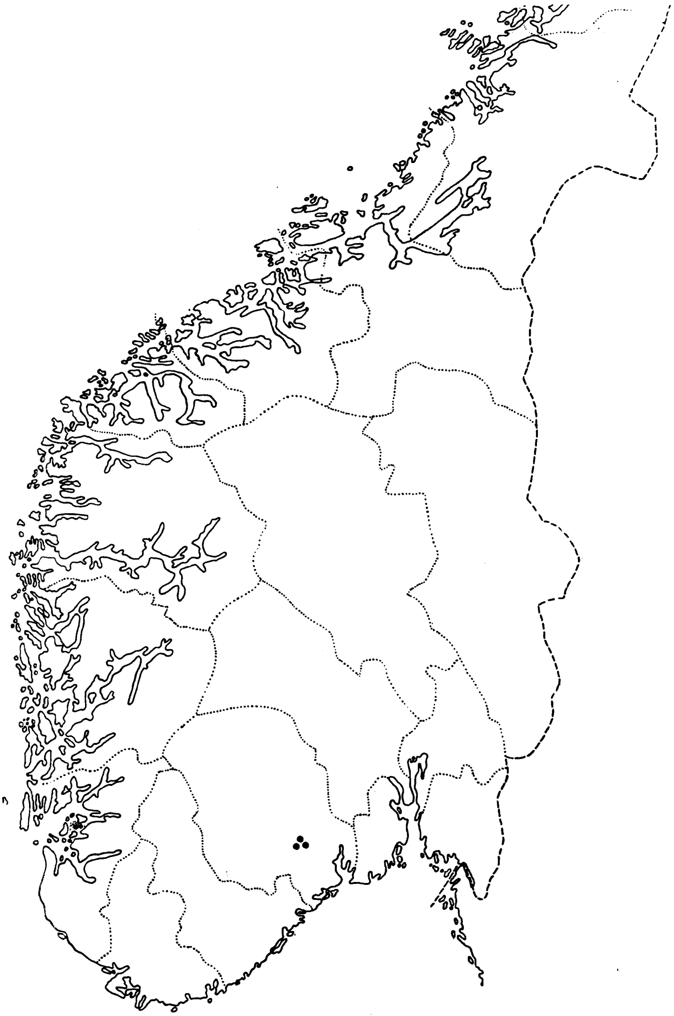

Fig. 37. The distribution of
Cirrospilus subviolaceus in the examined territories.

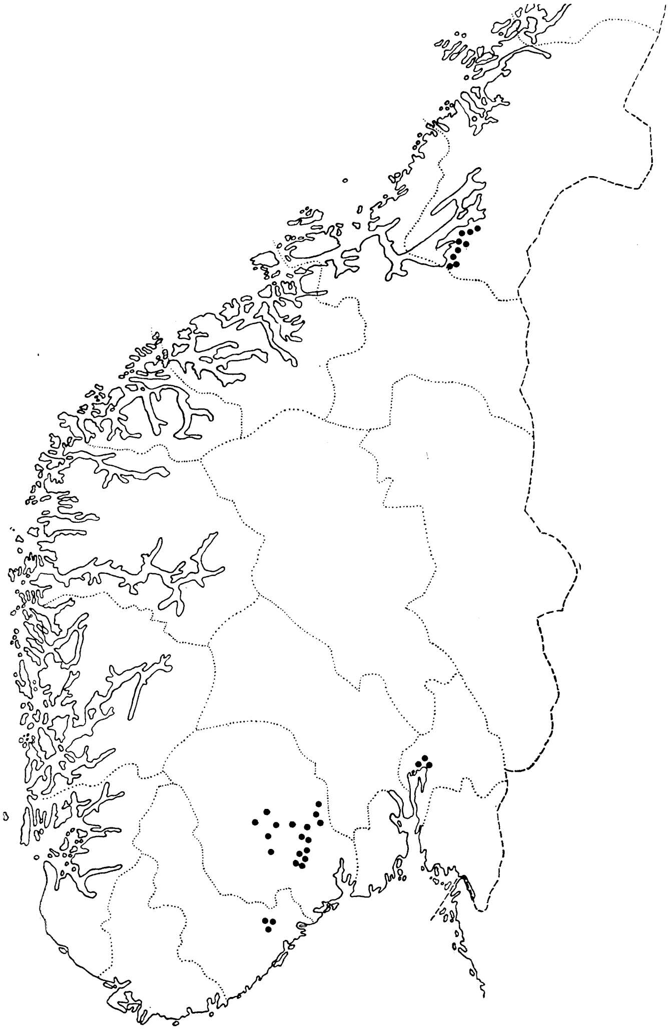

Fig. 38. The distribution of *Eulophus pectinicornis* in the examined territories.

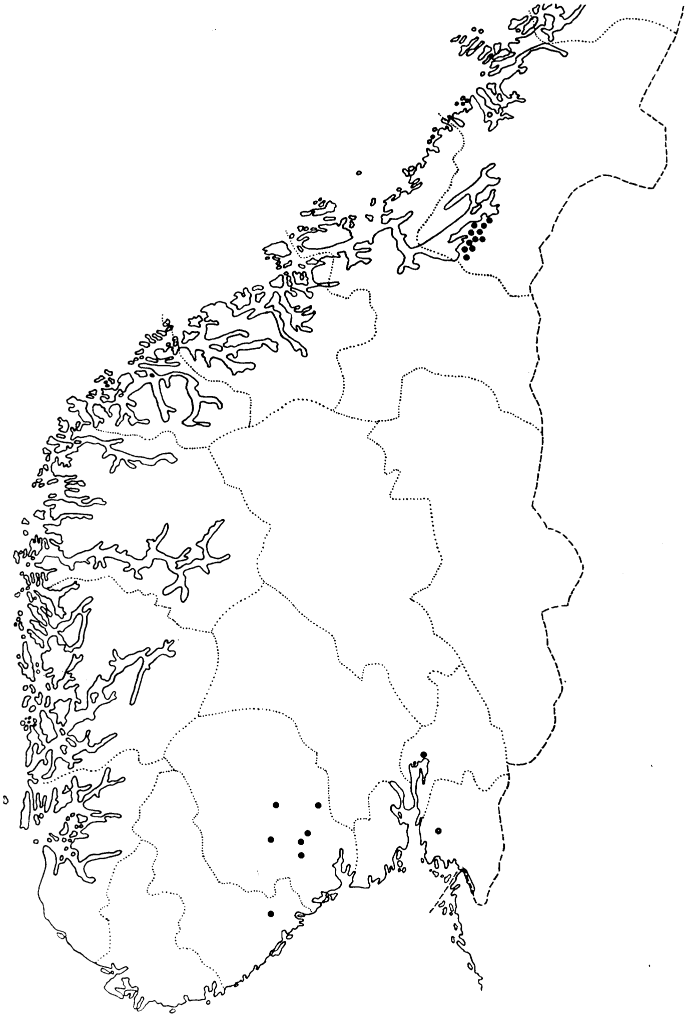

Fig. 39. The distribution of *Eulophus longulus* in the examined territories.

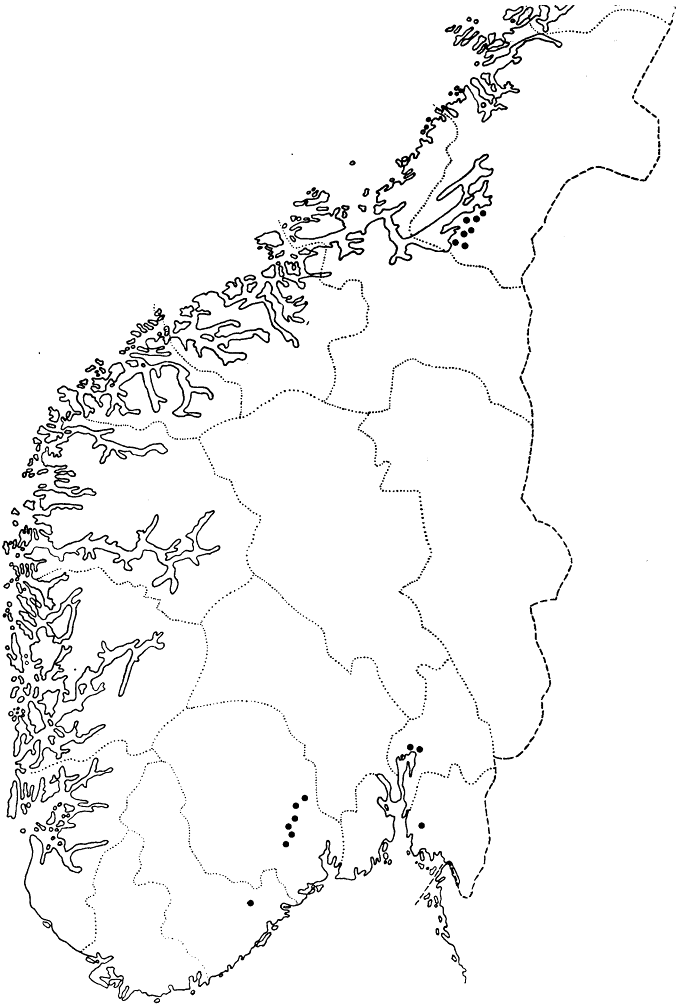

Fig. 40. The distribution of
Eulophus straminiepes in the examined territories.

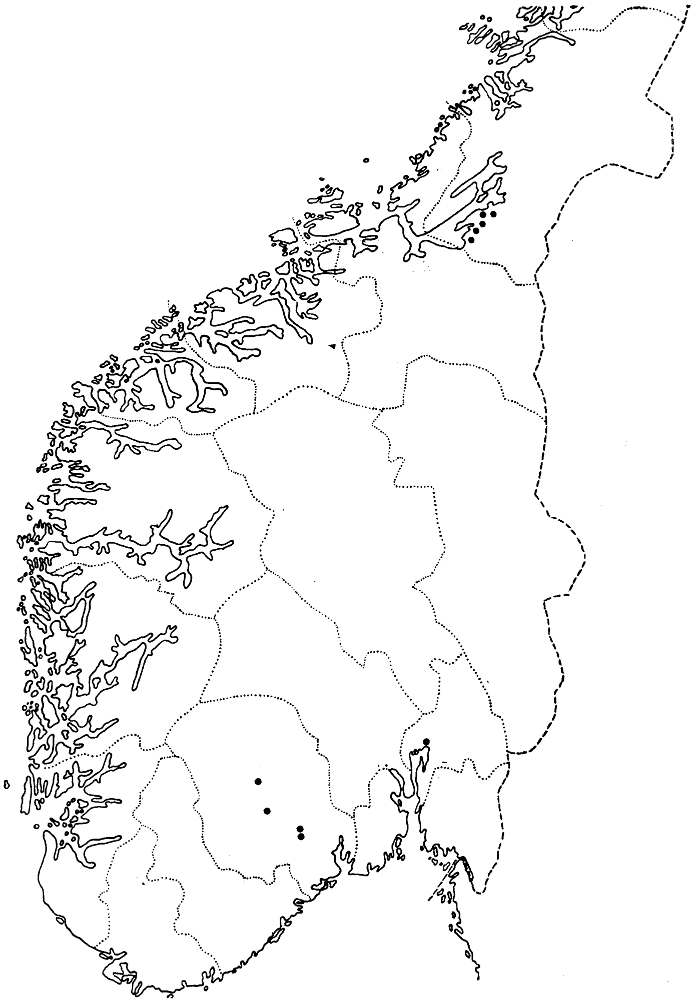

Fig. 41. The distribution of
Sympiesis sericeicornis in the examined territories.

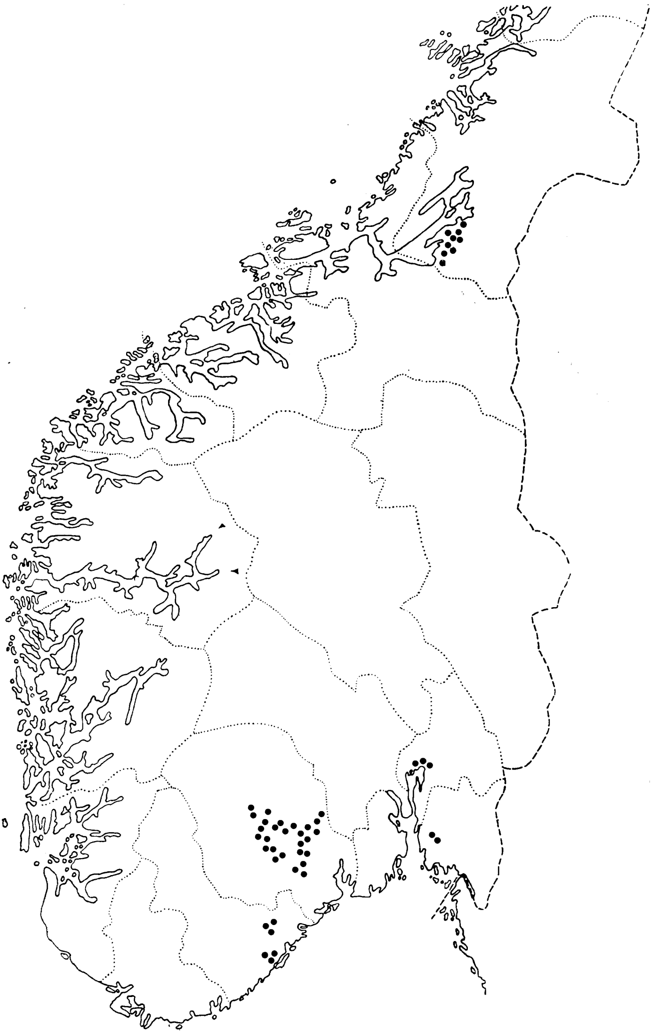

Fig. 42. The distribution of *Epilampsis tadici* in the examined territories.

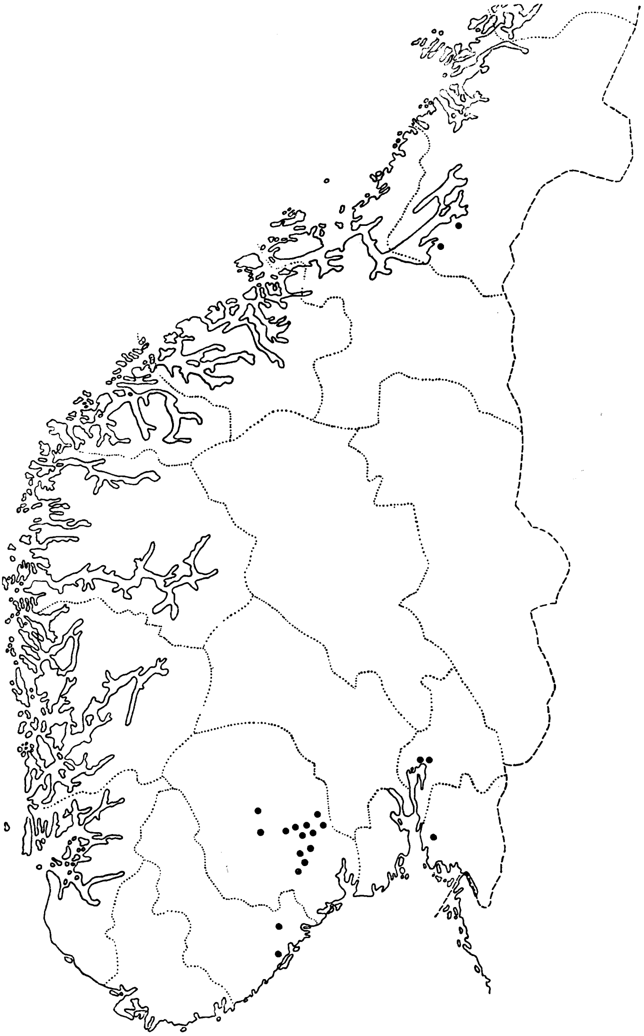

Fig. 43. The distribution of
Epilampsis gunholdi in the examined terriories.

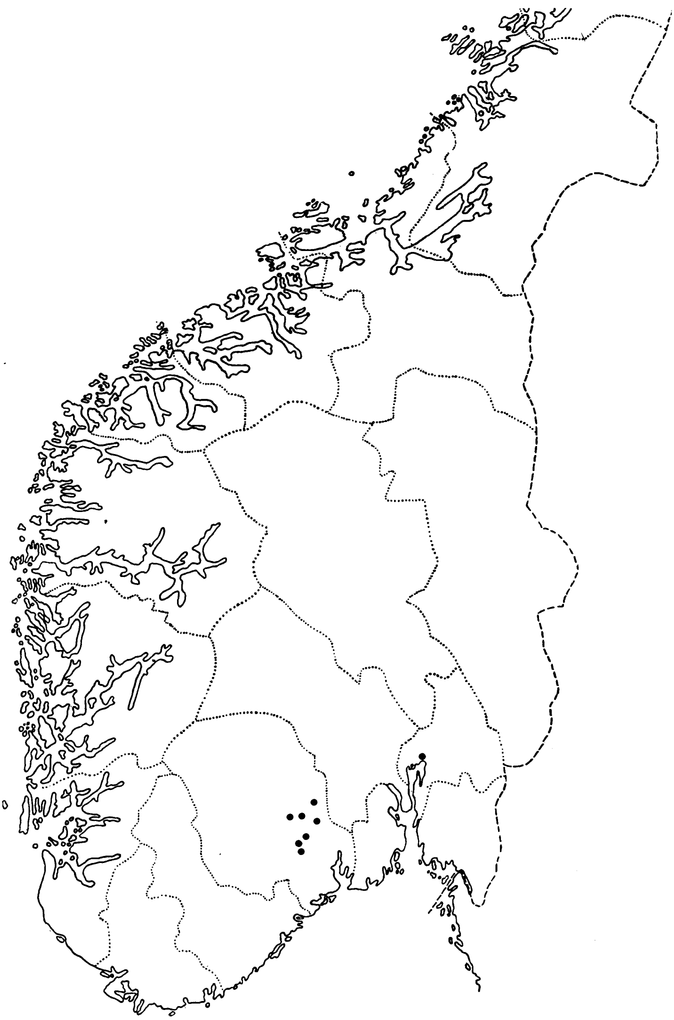

Fig. 44. The distribution of *Epilampsis mirabilis* in the examined territories.

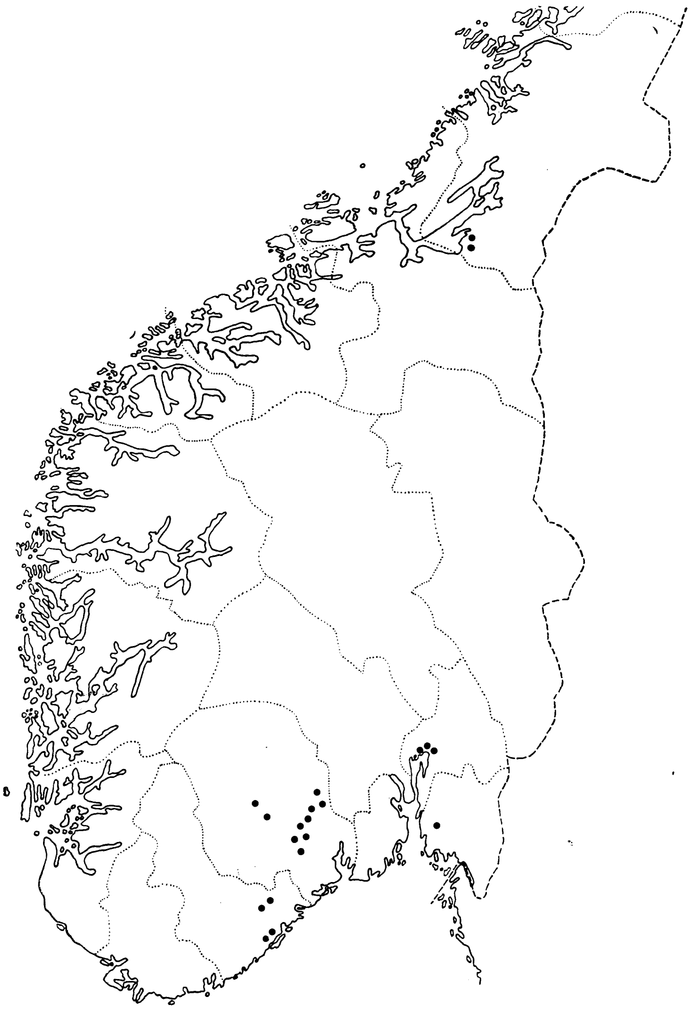

Fig. 45. The distribution of
Closterocerus trifasciatus in the examined territories.

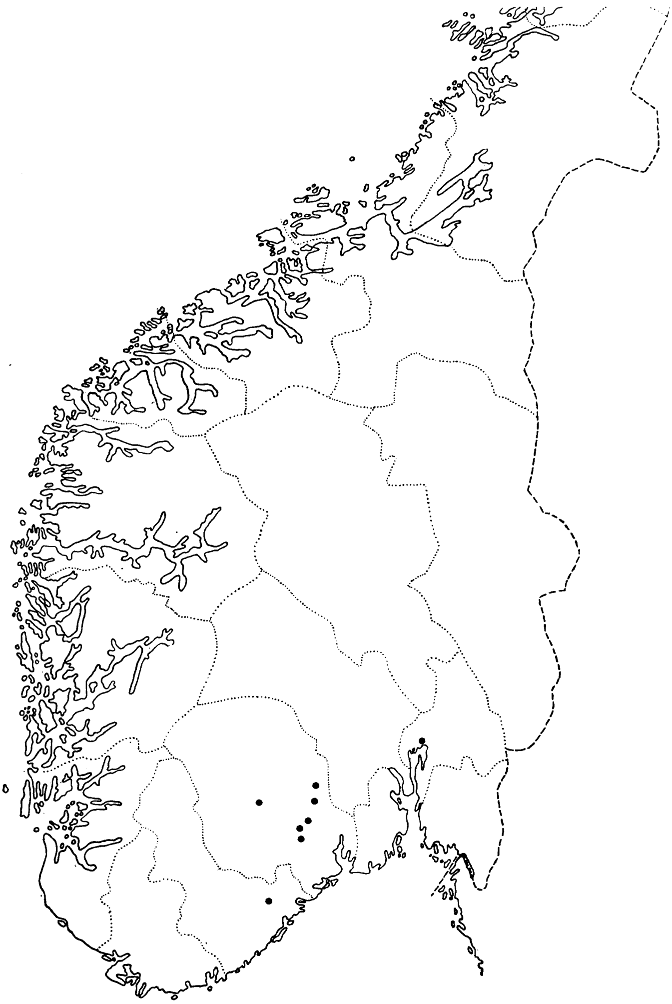

Fig. 46. The distribution of *Tetrastichus xanthops* in the examined territories.

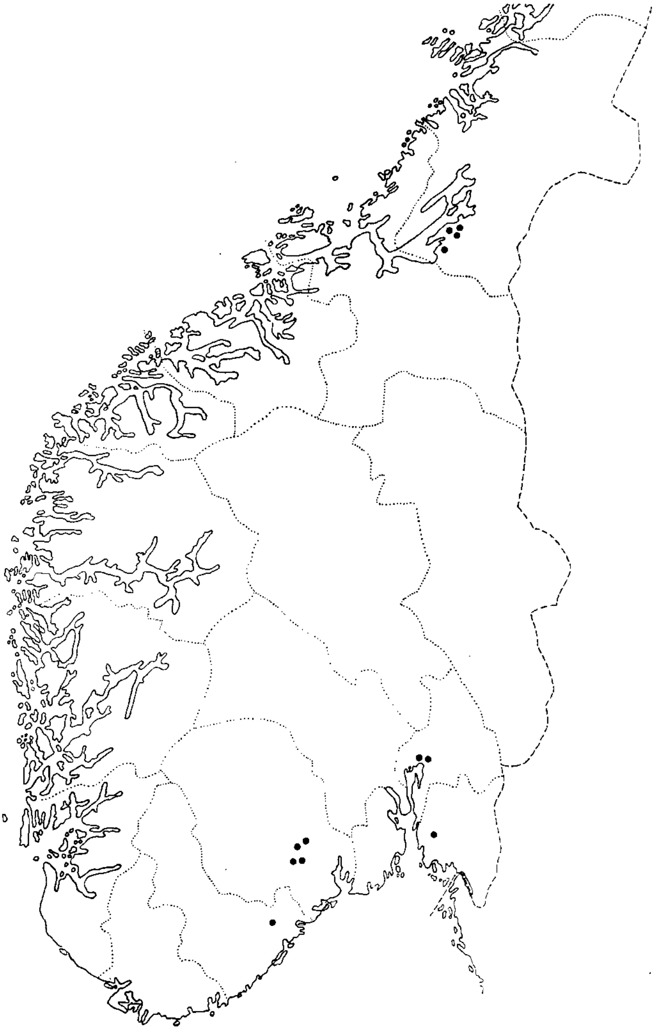

Fig. 47. The distribution of
Tetrastichus femoralis in the examined territories.

Table 5. The population density of Phyllocnistis labyrinthella, expressed by the proportion between the leaves attacked and unattacked

Oslo	1952				1954			
	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
120. Blindern	390	25.4	41.8	32.8	274	68.9	26.7	4.4
121. Berg	705	24.5	37.0	38.5	431	50.4	24.8	24.8
122. Østhorn	485	25.0	42.9	32.1	251	58.2	24.3	17.5
123. Sognsvann	455	22.0	29.7	48.3	383	34.5	48.0	17.5
124. Løren, early oviposition					467	55.7	7.5	36.8
125. Løren, late oviposition					241	73.0	21.8	5.2
Røa	441	86.0	11.3	2.7				

(Cont.)

Oslo	1955				1956			
	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
120. Blindern	705	24.5	37.0	38.5	444	70.3	23.6	6.1
121. Berg	493	39.0	33.2	27.8	1055	36.9	43.3	19.8
122. Østhorn	578	42.6	33.4	24.0	659	32.2	45.5	22.3
123. Sognsvann	311	67.5	23.5	9.0	766	22.6	51.0	26.4
124. Løren, early oviposition	413	37.0	33.9	29.1	943	26.6	44.2	29.2
125. Løren, late oviposition	469	45.4	26.2	28.4	806	9.7	40.0	50.3

Table 6 a. The population density of Phyllocnistis labyrinthella, expressed by the proportion between the leaves attacked and unattacked

Telemark	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
1952				
First line.				
1. Holtsås	276	54.0	37.3	8.7
2.	279	88.9	9.3	1.8
3.	272	79.0	19.5	1.5
4.	373	45.8	35.4	18.8
5.	219	33.8	54.8	11.4
6.	220	73.6	21.4	5.0
7. Noragutu ..	257	93.9	6.1	0.0
8.	252	97.2	2.0	0.8
9.	165	80.6	16.4	3.0
10.	254	95.7	4.3	0.0
11.	222	71.2	20.7	8.1
12.	273	46.5	44.7	8.8
13.	174	69.0	17.2	13.8
14. Bø	382	26.4	35.9	37.7
15.	176	82.4	13.6	4.0
16.	198	94.4	5.6	0.0
17.	309	88.0	9.7	2.3
18.	208	56.7	22.6	20.7
19.	261	38.3	34.9	26.8
20	297	18.2	48.5	33.3
21.	247	12.1	29.6	58.3
22.	202	55.4	21.3	23.3
23.	333	53.2	34.5	12.3
24. Lunde	262	81.7	15.6	2.7
25.	400	37.7	46.8	15.5
26.	299	48.8	37.1	14.1
27.	771	75.7	21.3	3.0
28.	576	91.8	8.0	0.2
29.	350	59.1	26.3	14.6
30.	602	64.5	27.7	7,8
31.	415	83.2	12.5	4.3
32.	482	48.5	36.5	15.0
33.	448	58.7	26.8	14.5
34.	530	38.5	34.7	26.8
35.	937	32.1	52.8	15.1
36.	724	81.2	14.6	4.2
37.	294	25.5	40.1	34.4
38.	664	2.5	14.8	82.7
39.				
40.	462	1.5	16.2	82.3
41. Drangedal..				

Table 6 b. The population density of Phyllocnistis labyrinthella, expressed by the proportion between the leaves attacked and unattacked

Telemark	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
1952 Second line.				
50. Bø	458	59.4	29.9	10.7
51.	354	82.5	14.1	3.4
52.	533	24.2	45.2	30.6
53.	332	41.3	46.7	12.0
54.	391	51.2	35.3	13.5
55.	571	60.8	28.2	11.0
56.	410	31.2	44.2	24.6
57.	287	84.0	13.9	2.1
58.	300	73.7	21.3	5.0
59.	207	82.6	9.7	7.7
60.	311	39.5	41.5	19.0
61.	288	12.5	29.2	58.3
62.	368	62.5	30.2	7.3
63. Seljord	277	0.7	8.7	90.6
64.	359	59.9	32.3	7.8
65.	385	69.4	22.9	7.8
66.	336	45.8	35.7	18.5
67. Brunkeberg	300	78.7	12.3	9.0
68.	388	69.1	21.3	9.5
69.	325	75.1	15.7	9.2
70.	298	68.1	21.8	10.1
71. Kvitseid ..	408	64.7	23.0	12.3
72.	772	6.7	33.6	59.7
73. Vrådal	593	1.0	6.2	92.8
74.	706	7.6	24.8	67.6
75.	715	1.0	13.7	85.3
76. Tørdal	972	1.8	13.2	85.0
Third line.				
80. Brunkeberg	440	22.0	42.5	35.5
81.	533	33.0	32.5	34.5
82.	288	76.4	7.6	16.0
83. Morgedal...	370	10.0	37.0	53.0
84.	347	60.2	28.8	11.0
85.	444	11.5	32.0	56.5
86.	285	31.6	45.6	22.8
87.	274	36.5	28.1	35.4
88.	335	12.2	38.5	49.3
89. Høydalsmo	238	2.9	23.5	73.6

Table 6 c. The population density of Phyllocnistis labyrinthella, expressed by the proportion between the leaves attacked and unattacked

Telemark	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
1954				
27.	369	94,4	5.3	0.3
28.	277	83.0	12.3	4.7
29.	188	46.8	43.6	9.6
30.	428	51.2	30.6	18.2
31.	369	52.9	24.1	23.0
32.	406	90.2	8.1	1.7
33.	480	77.5	16.7	5.8
34.	302	92.4	6.6	1.0
35.	392	25.8	35.2	39.0
36.	427	68.0	25.0	7.0
37.	429	42.4	35.2	22.4
38.	489	47.8	29.9	22.3
39.	229	7.4	35.4	57.2
40.	344	16.0	48.5	35.5
41.	598	9.4	25.9	64.7
1955				
27.	230	91.8	4.3	3.9
28.	284	62.6	26.7	10.7
29.	448	84.2	15.6	0.2
30.	446	62.4	26.8	10.8
31.	366	71.3	23.0	5.7
32.	386	86.5	12.2	1.3
33.	378	85.7	13.0	1.3
34.	407	52.6	30.7	16.7
35.	235	90.6	8.5	0.9
36.	337	60.5	30.9	8.6
37.	435	37.0	33.8	29.2
38.	559	1.6	28.8	69.6
39.	486	2.7	29.6	67.7
40.	499	37.7	36.5	25.8
41.	467	21.8	31.3	46.9
1956				
27.	556	63.5	29.0	7.5
28.	722	34.8	40.7	24.5
29.	462	84.4	12.6	3.0
30.	512	58.6	26.8	14.6
31.	510	65.9	28.4	5.7
32.	530	83.7	15.5	0.8
33.	967	74.5	21.4	4.1
34.	614	61.3	31.2	7.5
35.	853	71.9	23.8	4.3
36.	866	66.2	28.4	5.4
37.	529	3.8	26.5	69.7
38.	613	72.2	23.7	4.1
39.	654	57.5	31.6	10.9
40.	761	14.7	41.1	44.2
41.	478	18.2	29.3	52.5

Table 7. The population density of Phyllocnistis labyrinthella, expressed by the proportion between the leaves attacked and unattacked

Trøndelag	1954				1955				1956			
	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked	Number of controlled leaves	% leaves attacked on both sides	% leaves attacked on one side	% leaves unattacked
101. Skatval					187	27.8	41.7	30.5	417	41.5	40.3	18.2
102.					234	10.7	35.9	53.4	335	56.7	32.5	10.8
103.	270	70.0	28.5	1.5	397	39.8	42.3	17.9	539	37.3	37.7	25.0
104. Langstein	158	70.9	25.3	3.8	326	38.3	44.8	16.9	661	55.5	35.3	9.2
105.	203	60.6	32.0	7.4	230	56.6	33.0	10.4	368	45.4	45.4	9.2
106.	156	84.6	12.8	2.6	148	37.1	53.4	9.5	233	83.7	14.2	2.1
107. Åsen	228	88.0	11.0	1.0	329	32.2	47.4	20.4	410	51.7	33.7	14.6
108.	184	98.0	2.0	0.0	260	8.5	30.0	61.5	388	34.3	46.1	19.6
109.					314	23.6	50.6	25.8	526	31.0	41.4	27.6
110.					313	27.2	48.5	24.3	430	25.1	53.3	21.6
111.					280	45.0	33.9	21.1	503	6.0	27.4	66.6
112. Levanger					164	51.8	38.4	9.8	419	36.1	39.1	24.8

Table 8. Duration of oviposition and feeding time

	Female emerged	Intro-duction of the host	First feeding	Oviposi-tion	Duration of host finding				Duration of feeding puncture				Duration of paralysing puncture			
					Max.	Min.	Aver.	Obs.	Max.	Min.	Aver.	Obs.	Max.	Min.	Aver.	Obs.
Cirrospilus vittatus	21/5	18/6	18/6	20/6–10/7												
	26/5	2/6	2/6	5/6– 3/7	14m	10m	12m	2	2m, 15s	5s	2m	5	2m, 48s	5s	1m,28s	5
	28/5	6/6	6/6	6/6– 5/7												
	10/7	15/7	15/7	15/7–23/8	25m	3m	12m,40s	3					31s	10s	19s	8
	18/7	26/7	26/7	26/7–18/8	30m			1								
Cirrospilus pictus	26/5	10/6	12/6	13/6– 5/7	25m	5m	13m,34s	7					55s	12s	30s	12
	5/7	15/7	15/7	15/7–17/8												
	6/7	15/7	15/7	15/7–14/8												
	14/7	26/7	26/7	26/7–22/8	10m	3m	6m	3	2m,45s	7s	37m,15s	8	1m, 50s	23s	59s	5
	17/7	2/8	3/8	3/8–30/8	25m	15m	16m,15s	4	5m, 49s	2s	1m,27s	10	1m, 53s	5s	51s	6
	18/7	24/7	24/7	30/7–17/8	15m	5m	11m,30s	4	4m, 55s	1m,16s	2m,25s	5	1m, 14s	5s	30s	15
Cirrospilus elegantissimus	8/7	12/7	14/7	15/7–19/8												
	20/7	28/7	28/7	26/8– 7/9					3m	25s	51s	4	2m, 47s	7s	46s	7
	22/7	13/8	13/8	17/8–31/8	15m	7m	10m,40s	3					3m, 6s	2s	41s	18
Eulophus pectinicornis	25/6	6/6	6/6	6/6–23/6												
	18/7	24/7	24/7	29/7–30/8	6m	5m	5m,15s	4	1m, 8s	5s	23s	4	1m, 14s	5s	29s	7
	20/7	27/7	27/7	30/7–30/8					2m	10s	43s	19	40s	2s	30s	15
	20/7	1/8	1/8	17/8–23/8												
	21/7	28/7	28/7	5/8–20/8	5m	5m	5m	4	5m, 5s	2s	1m,5s	10				
Eulophus longulus	17/5	16/6	16/6	22/6–24/6					2m, 29s	2s	51s	12	45s	2s	15s	11
	18/5	10/6	10/6	13/6–21/6	25m	3m	13m	5	2m, 3s	15s	53s	15				
	19/5	3/6	3/6	10/6–21/6					2m, 5s	7s	1m,9s	10				
	20/5	4/6	5/6	6/6–20/6	25m	5m	14m	5								
	18/7	30/7	30/7	3/8– 3/9	45m	15m	26m	4	2m, 28s	5s	49s	26	30s	5s	13s	4
Epilampsis tadici	23/5	2/6	2/6	6/6–18/6					2m	43s	1m,21s	2				
	16/7	25/7	25/7	30/7–18/8	15m	2m	8m	7	18s	6s	12s	4				
	17/7	2/8	16/8	17/8–30/8	18m	3m	10m	12	3m,2s	15s	54s	23				
	18/7	25/7	26/7	30/7– 3/9												
	18/7	25/7	4/8	4/8–15/8	20m	15m	17m		25s	10s	19s	6				
	21/7	25/7	25/7	26/7–18/8					5m, 17s	30s	1m,26s	7				
Epilampsis gunholdi	20/5	2/6	2/6	3/6– 5/6												
	21/5	1/6	1/6	2/6–10/6												
Closterocerus trifasciatus	25/5	9/6	18/6	21/6												
	12/7	14/7	14/7	18/7– 9/8												
	20/7	28/7	28/7	2/8–30/8												
	21/7	25/7	5/8	8/8–12/8	40m	20m	27m	4								
Tetrastichus xanthops	11/7	14/7	15/7	15/7–14/8	45m	3m	19m	3								
	17/7	24/7	25/7	27/7–18/8									3m	20s	1m,20s	6
	21/7	26/7	27/7	12/8–28/8												
Tetrastichus femoralis		3/6	5/6	5/6– 3/7									26s	5s	14s	6
	15/7	25/7	26/7	26/7–23/8	15m	5m	10m	3	7m, 37s	12s	3m,57s	7				
	16/7	24/7	25/7	31/7–28/8												

Table 8. (Cont.)

	Female emerged	Introduction of the host	First feeding	Oviposition	Duration of stings before oviposition				Duration of oviposition				Greatest number of oviposition puncture
					Max.	Min.	Aver.	Obs.	Max.	Min.	Aver.	Obs.	
Cirrospilus vittatus	21/5	18/6	18/6	20/6–10/7	30m								
	26/5	2/6	2/6	5/6– 3/7				1	2m, 32s	45s	1m, 43s	4	
	28/5	6/6	6/6	6/6– 5/7									
	10/7	15/7	15/7	15/7–23/8					2m, 31s	1m, 52s	2m, 18s	3	
	18/7	26/7	26/7	26/7–18/8									
Cirrospilus pictus	26/5	10/6	12/6	13/6– 5/7	2m, 10s	7s	47s	7	3m, 46s	1m, 23s	2m, 18s	4	5
	5/7	15/7	15/7	15/7–17/8									
	6/7	15/7	15/7	15/7–14/8									
	14/7	26/7	26/7	26/7–22/8	55s	21s	39s	6	3m, 16s	1m, 31s	2m, 45s	5	7
	17/7	2/8	3/8	3/8–30/8	1m, 10s	1m	1m,2s	4	4m, 27s	2m, 29s	3m, 10s	4	
	18/7	24/7	24/7	30/7–17/8	2m, 28s	2s	51s	8	3m, 8s	56s	2m, 1s	8	31
Cirrospilus elegantissimus	8/7	12/7	14/7	15/7–19/8									
	20/7	28/7	28/7	26/8– 7/9					2m, 50s	1m, 34s	2m, 23s	3	2
	22/7	13/8	13/8	17/8–31/8					3m, 44s	69s	2m, 19s	4	11
Eulophus pectinicornis	25/5	6/6	6/6	6/6–23/6									
	18/7	24/7	24/7	29/7–30/8					1m, 42s	1m, 19s	1m, 30s	2	
	20/7	27/7	27/7	30/7–30/8					54s	16s	38s	13	1
	20/7	1/8	1/8	17/8–23/8									
	21/7	28/7	28/7	5/8–20/8					45s	36s	40s	2	
Eulophus longulus	17/5	16/6	16/6	22/6–24/6					1m, 14s	20s	45s	9	
	18/5	10/6	10/6	13/6–21/6									
	19/5	3/6	3/6	10/6–21/6					1m, 25s	35s	1m	4	
	20/5	4/6	5/6	6/6–20/6									
	18/7	30/7	30/7	3/8– 3/9					55s	43s	49s	2	
Epilampsis tadici	23/5	2/6	2/6	6/6–18/6					2m, 55s	58s	1m, 46s	12	
	16/7	25/7	25/7	30/7–18/8	18s	3s	10s	5	3m	45s	1m, 38s	12	
	17/7	2/8	16/8	17/8–30/8					2m, 5s	51s	1m, 18s	14	
	18/7	25/7	26/7	30/7– 3/9									
	18/7	25/7	4/8	4/8–15/8					1m, 30s	1m, 9s	1m, 19s	3	
	21/7	25/7	25/7	26/7–18/8					2m, 18s	31s	1m, 23s	6	
Epilampsis gunholdi	20/5	2/6	2/6	3/6– 5/6									
	21/5	1/6	1/6	2/6–10/6	1m, 51s	6s	48s	3	2m, 55s	45s	1m, 39s	5	
Closterocerus trifasciatus	25/5	9/6	18/6	21/6									
	12/7	14/7	14/7	18/7– 9/8	1m, 23s	40s	59s	8	3m, 43s	1m, 40s	2m, 17s	4	
	20/7	28/7	28/7	2/8–30/8									
	21/7	25/7	5/8	8/8–12/8									
Tetrastichus xanthops	11/7	14/7	15/7	15/7–14/8									
	17/7	24/7	25/7	27/7–18/8					4m, 22s	40s	2m, 21s	3	
	21/7	26/7	27/7	12/8–28/8									
Tetrastichus femoralis		3/6	5/6	5/6– 3/7	1m, 44s	6s	30s	15	3m, 12s	1m, 30s	2m, 26s	5	
	15/7	25/7	26/7	26/7–23/8									
	16/7	24/7	25/7	31/7–28/8									

Table 9. The length of the pupae, developed at different hosts

	The length of the pupae mm	Host	Remarks
Cirrospilus vittatus Host: Phyllocnistis labyrinthella	0.68	Ph. lab.	
	1.04	»	
	1.25	»	
	1.31 1.12	»	2 pupae at the same host
	1.45	»	
	1.52	»	
	1.53	»	
	1.80	»	
	2.04	»	
Cirrospilus vittatus Host: Lyonetia clerckella	1.50	»	
	1.53	»	
	1.63	»	
	1.67	»	
	1.77	»	
Cirrospilus pictus. Host: Phyllocnistis labyrinthella	1.50	»	
	1.55	»	
	1.61	»	The host not consumed
	1.72	»	
	1.77	»	
	1.88	»	
	1.91	»	
	1.96	»	
	2.16	»	
	2.18	»	
	2.46	Lyon. clerck.	
Cirrospilus pictus. Host: Phyllocnistis labyrinthella	1.72	Ph. lab.	
	1.75	»	
	2.02	»	
	2.29	»	
	2.30	Lyon. clerck.	The host not consumed
Cirrospilus pictus Host: Lyonetia clerckella	1.09	Ph. lab.	
	1.77	»	Length of host: 3.3 mm
	1.83	»	
	1.86	»	
	1.88	»	
Cirrospilus elegantissimus Host: Phyllocnistis labyrinthella	1.34	»	
	1.37	»	
	1.45	»	
	1.56	»	
	1.66	»	
	1.96	»	
	1.99	»	
Eulophus pectinicornis Host: Phyllocnistis labyrinthella	1.42	»	
	2.05	»	
	2.07	»	Hibernated
	2.13	»	
	2.14	»	
	2.18	»	The host not consumed
	2.24	»	
	2.29	»	
	2.37	»	
	2.46	»	
	2.70	»	

Table 9. (Cont.)

	The length of the pupae mm	Host	Remarks
Eulophus pectinicornis Host: Phyllocnistis labyrinthella	1.64	Lyon. clerck.	Hibernated
	2.05	»	»
	2.18	»	»
	2.19	»	»
	2.32	»	»
	2.35	»	»
	2.40	»	»
Eulophus pectinicornis Host: Phyllocnistis labyrinthella	2.04	Ph. lab.	»
	2.05	»	
	2.10	»	Emerged the same year
	2.16	»	Hibernated
Eulophus pectinicornis Host: Lyonetia clerckella	1.50	»	»
	1.94	»	Emerged the same year
	2.18	»	»
Eulophus longulus. Host: Phyllocnistis labyrinthella	2.04	»	Hibernated
	2.05	»	»
Eulophus longulus. Host: Lyonetia clerckella	2.18	»	»
	2.34	»	»
	2.48	Lyon. clerck.	»
	2.62	»	»
	2.86	»	»
Eulophus longulus Host: Lyonetia clerckella	2.18	»	»
	2.18	Ph. lab.	»
	2.18	»	»
	2.32	»	»
	2.32	»	»
Eulophus longulus. Host: Lyonetia clerckella	2.02	Lyon. clerck.	»
	2.37	»	»
	2.51	»	» Host: 5.4 mm
	2.73	»	» Host: 6.0 mm
Epilampsis tadici. Host: Phyllocnistis labyrinthella	1.42	Ph. lab.	
	1.75	»	
	2.07	»	
	2.21	»	
	2.27	»	
Epilampsis tadici. Host: Lyonetia clerckella	1.72	»	
	1.88	»	
	2.07	»	

Table 10. The number of eggs and duration of oviposition period for each single female

	Total number of eggs during the laboratory exp.	Duration of oviposition period, days	Greatest number of eggs placed the same day	Number of females used	Greatest number of eggs found in or at a single host
Cirrospilus vittatus	4	10	7	8	7
	6	19			
	11	15			
	14	19			
	23	17			
	33	29			
	38	30			
	58	40			
Cirrospilus pictus	3	4	5	14	5
	5	9			
	6	12			
	6	28			
	7	41			
	9	11			
	12	28			
	13	19			
	15	10			
	20	19			
	24	17			
	45	27			
	45	34			
	45	43			
Cirrospilus elegantissimus	6	13	4	3	1
	7	15			
	38	35			
Cirrospilus subviolaceus	36	34	5	1	5
Eulophus pectinicornis	2	7	4	5	4
	10	16			
	13	33			
	20	32			
	33	18			

Table 10. (Cont.)

	Total number of eggs during the laboratory exp.	Duration of oviposition period, days	Greatest number of eggs placed the same day	Number of females used	Greatest number of eggs found in or at a single host
Eulophus longulus	4	2	3	9	2
	4	14			
	4	32			
	5	12			
	6	17			
	7	11			
	10	17			
	13	30			
	14	14			
Epilampsis tadici	6	14	3	7	3
	7	13			
	16	19			
	19	23			
	21	26			
	21	36			
	38	29			
Epilampsis gunholdi	2	2	5	5	2
	4	2			
	7	3			
	8	7			
	22	9			
Closterocerus trifasciatus	2	9	5	4	1
	5	29			
	13	16			
	35	23			
Tetrastichus xanthops	10	16	8	3	14
	23	22			
	24	31			
Tetrastichus femoralis	3	6	4	3	2
	15	29			
	21	29			

Table 11. The number of eggs each day during the oviposition period

	Oviposition days:																			
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Cir. vittatus	4	—	—	4	1	—	—	3	—	3	3	6	1	2	2	1	2	1	3	5
Cir. pictus...........	3	—	—	2	2	—	2	2	1	2	2	2	—	—	—	—	4	1	1	1
Cir. elegantissimus	1	—	—	2	1	—	1	2	1	1	1	4	2	1	1	2	2	1	3	2
Cir. subviolaceus	1	1	2	1	—	—	3	—	—	—	3	1	1	2	2	1	1	3	1	5
Eulop. pectinicornis....	5	3	4	2	1	—	3	—	1	1	5	2	—	2	2	—	1	1		
Eulop. longulus	2	—	3	1	—	—	1	—	—	2	2	2	—	1						
Epil. tadici..........	3	3	—	3	—	2	—	1	—	2	2	—	1	4	1	1	2	2	—	—
Epil. gunholdi	3	2	1	3	4	3	3	1	3											
Clost. trifasciatus......	2	1	1	—	1	2	1	—	—	—	—	1	—	2	1					
Tetrast. xanthops	5	—	—	—	1	—	2	—	—	1	—	1	—	—	1	—	—	1	1	5

(Cont).

	Oviposition days:																			
	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Cir. vittatus..........	2	2	7	2	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	2
Cir. pictus	2	2	5	2	1	1	—	—	1	1	2	1	—	2						
Cir. elegantissimus	1	2	—	1	1	1	—	—	—	1	1	1	—	1						
Cir. subviolaceus	0	1	1	2	1	—	1	—	—	1	—	—	—	—	1					
Eulop. pectinicornis ...																				
Eulop. longulus																				
Epil. tadici	—	—	3	—	1	1	1	—	5											
Epil. gunholdi																				
Clost. trifasciatus......																				
Tetrast. xanthops......	—	—	—	3	—	2	—	—	—	—	1									

Table 12. The frequency of the parasites expressed by per cent of emerged moth and parasites

Oslo	1952				1954			
	Number of emerged animals	Moths	Para-sites	Number of animals/ leaf	Number of emerged animals	Moths	Para-sites	Number of animals/ leaf
120. Blindern	174	76.4	23.6	0.4	521	97.1	2.9	1.9
121. Berg	381	74.0	26.0	0.5	701	85.2	14.8	1.6
122. Østhorn	307	75.0	25.0	0.6	352	93.8	6.2	1.4
123. Sognsvann	212	80.2	19.8	0.5	349	96.0	4.0	0.5
124. Løren, early oviposition					572	96.9	3.1	1.2
125. Løren, late oviposition					545	97.4	2.6	2.3
Røa	493	81.8	18.2	1.1				

(Cont.)

	1955				1956			
	Number of emerged animals	Moths	Para-sites	Number of animals/ leaf	Number of emerged animals	Moths	Para-sites	Number of animals/ leaf
120. Blindern	307	75.0	25.0	0.4	527	80.1	19.9	1.2
121. Berg	436	89.9	10.1	0.9	706	77.5	22.5	0.7
122. Østhorn	434	91.0	9.0	0.8	618	85.9	14.1	0.9
123. Sognsvann	480	93.8	6.2	1.5	530	91.5	8.5	0.7
124. Løren, early oviposition	369	95.9	4.1	0.9	527	69.5	30.5	0.6
125. Løren, late oviposition	298	91.6	8.4	0.6	203	86.2	13.8	0.3

Table. 13 a. The frequency of the parasites expressed by per cent of emerged moth and parasites.

Telemark	1952				1954				1955				1956			
	Number of emerged animals	% moths	% parasites	Number of animals/leaf	Number of emerged animals	% moths	% parasites	Number of animals/leaf	Number of emerged animals	% moths	% parasites	Number of animals/leaf	Number of emerged animals	% moths	% parasites	Number of animals/leaf
First line																
1. Holtsås	333	76.3	23.7	1.2												
2.	357	92.7	7.3	1.3												
3.	299	88.6	11.4	1.1												
4.	141	85.1	14.9	0.4												
5.	83	77.1	22.9	0.4												
6.	280	78.9	21.1	1.3												
7. Noragutu	293	91.5	8.5	1.1												
8.	387	82.9	17.1	1.5												
9.	140	92.8	7.2	0.8												
10.	147	91.8	8.2	0.6												
11.	234	89.7	10.3	1.1												
12.	171	74.8	25.2	0.6												
13.	140	92.8	7.2	0.8												
14. Bø	209	75.6	24.4	0.5												
15.	148	89.2	10.8	0.8												
16.	371	88.4	11.6	1.9												
17.	238	76.9	23.1	0.8												
18.	173	88.4	11.6	0.8												
19.	168	75.6	24.4	0.6												
20.	169	84.0	16.0	0.6												
21.	82	84.2	15.8	0.3												
22.	132	84.8	15.2	0.7												
23.	243	82.7	17.3	0.7												
24. Lunde	293	69.3	30.7	1.1												
25.	270	77.1	22.9	0.7												
26.	191	81.7	18.3	0.6												
27.	685	80.7	19.3	0.9	469	72.5	27.5	1.3	363	92.3	7.7	1.6	384	85.7	14.3	0.7
28.	657	81.1	18.9	1.1	522	92.5	7.5	1.9	250	64.8	35.2	0.9	386	79.5	20.5	0.5
29.	310	76.1	23.9	0.9	127	67.7	32.3	0.7	386	76.4	23.6	0.9	408	79.7	20.3	1.0
30.	379	75.2	24.8	0.6	310	85.8	14.2	0.7	131	79.4	20.6	0.3	416	76.8	23.2	0.8
31.	263	80.6	19.4	0.6	376	63.8	36.2	1.0	235	68.5	31.5	0.6	415	80.0	20.0	0.8
32.	343	77.5	22.5	0.7	435	47.1	52.9	1.1	139	54.0	46.0	0.4	363	64.2	35.8	0.7
33.	146	76.0	24.0	0.3	83	57.8	42.2	0.2	209	67.0	33.0	0.6	796	74.0	26.0	0.9
34. *Limit of pest attack*	100	80.0	20.0	0.2	360	66.9	33.1	1.2	166	72.9	27.1	0.4	624	67.7	32.3	1.0
35.	135	67.4	32.6	0.1	270	59.3	40.7	0.7	146	70.5	29.5	0.6	586	65.5	34.5	0.7
36.	147	63.3	36.7	0.2	224	55.8	44.2	0.7	183	67.8	32.2	0.5	540	57.8	42.2	0.6
37.	23	69.6	30.4	0.08	89	55.1	44.9	0.2	192	69.3	30.7	0.4	36	58.3	41.7	0.07
38.	14	71.4	28.6	0.02	169	59.2	40.8	0.3	60	63.3	36.7	0.1	147	64.6	35.4	0.2
39.					170	51.2	48.8	0.5	127	57.5	42.5	0.2	327	62.1	37.9	0.5
40.	16	81.2	18.8	0.03	30	63.2	36.8	0.1	78	64.1	35.9	0.3	133	52.6	47.4	0.2
41. Drangedal					103	45.6	54.4	0.2	57	56.1	43.9	0.1	108	65.7	34.3	0.2

Table 13 b. The frequency of the parasites expressed by per cent of emerged moth and parasites

Telemark	1952			
	Number of emerged animals	% moths	% parasites	Number of animals/leaf
Second line				
50. Bø	371	93.5	6.5	0.8
51.	351	95.4	4.6	1.0
52.	310	89.0	11.0	0.6
53.	311	87.5	12.5	0.9
54.	245	84.5	15.5	0.6
55.	351	87.7	12.3	0.6
56.	155	87.7	12.3	0.4
57.	371	87.3	12.7	1.3
58.	274	90.5	9.5	0.9
59.	330	80.3	19.7	1.6
60.	218	89.4	10.6	0.7
61.	60	91.7	8.3	0.02
62.	156	73.7	26.3	0.4
63. Seljord	16	93.8	6.2	0.06
64.	317	83.6	16.4	0.9
65.	341	64.2	35.8	0.9
66.	295	82.4	17.6	0.9
67. Brunkeberg	186	87.1	12.9	0.6
68.	288	87.5	12.5	0.7
69.	224	86.2	13.8	0.7
70.	253	79.8	20.2	0.8
71. Kvitseid	232	83.6	16.4	0.6
72.	155	85.8	14.2	0.2
73. Vrådal	24	79.2	20.8	0.04
74.	77	66.2	33.8	0.1
75.	35	68.6	31.4	0.05
76. Tørdal	35	71.4	28.6	0.04
Third line				
80. Brunkeberg	178	92.1	7.9	0.4
81.	212	58.9	41.1	0.4
82.	142	56.3	43.7	0.5
83. Morgedal	112	78.6	21.4	0.3
84.	392	51.8	48.2	1.1
85.	32	65.6	34.4	0.07
86.	194	65.0	35.0	0.7
87.	76	48.7	51.3	0.3
88.	17	88.2	11.8	0.05
89. Høydalsmo	18	77.8	22.2	0.07

Table 14. The frequency of the parasites expressed by per cent of emerged moth and parasites

Trøndelag	1954				1955				1956			
	Number of emerged animals	% moths	% parasites	Number of animals/leaf	Number of emerged animals	% moths	% parasites	Number of animals/leaf	Number of emerged animals	% moths	% parasites	Number of animals/leaf
101. Skatval					131	94.7	5.3	0.7	378	90.5	9.5	0.9
102.					107	87.8	12.2	0.5	460	91.3	8.7	1.4
103.	318	85.2	14.8	1.2	301	86.4	13.6	0.8	277	89.9	10.1	0.5
104. Langstein ...	344	92.2	7.8	2.2	123	71.6	28.4	0.4	734	83.0	17.0	1.3
105.	282	89.0	11.0	1.4	196	74.0	26.0	0.9	434	95.9	4.1	1.2
106.	378	96.3	3.7	2.4	218	94.5	5.5	1.5	578	93.4	6.6	2.5
107.	487	98.2	1.8	2.1	264	79.2	20.8	0.8	427	89.0	11.0	1.0
108.	332	97.0	3.0	1.8	87	94.3	5.7	0.3	402	93.3	6.7	1.0
109.					269	96.7	3.3	0.9	411	94.6	5.4	0.8
110.					180	72.2	27.8	0.6	333	87.1	12.9	0.8
111.					312	97.7	2.3	1.1	126	95.2	4.8	0.3
112. Levanger ...					247	89.1	10.9	1.5	402	88.1	11.9	1.0

Table 15. The parasitic wasps emerged from the different samples in Oslo

	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
1952	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
120–125	10	7	12	3	6	5			7	2	2	2		3		2	45	21	2	1			2	2			1		135
1953																													
120–125	32	8			3									1			139	58	12	3	3			1					260
1954																													
120	3		5						12	6	2	1	6	4		1	6										2	1	
121			9	5					2		2		2				25	23											
124–125		1	1	1									4	2			10	5									1		
	3	1	15	6					14	6	4	1	12	6		1	41	28									3	1	142
1955																													
120				1					2	2							5	1					1						
121	2		8	3					2	2						1	19	5			1								
122		1	1	1					1								1						1	2					
123	2		7	7					7	2			1			1	4	9					2					1	
124–125		1	18	16									1				2	3			1								
	4	2	34	28					12	6			1			2	31	18			2		4	2				1	148
1956																													
120	2	1	6	2					4	2						1	22	21			6		3	1					
121	2			2					2	1							5	3			2								
122	2	1	1	4					6	2							2	1					5	1			1		
123	2		6	4					10	2			3	3			18	8			1		8	9			1	2	
124	5		2			1											19	17					4	7			1	1	
125			6	3												2	4	5										1	
	13	2	21	15		1			22	7			3	3		3	70	55			9		20	18			3	4	269

Table 16a. The parasitic wasps emerged from the different samples in Telemark.

	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
1952																													
1.	2		3	1	5	2			1								4	2			1	1	4	1	3				
2.	23	4	15	3	6					2			1	2			11	8							1				
3.	5		1	1	2												15	6	1	2									
4.	6	1			1	1				1							22	13	6	2									
5.	1				6				1		1						11	1		1									
6.	8	3															57	1	1		1								
7.	4		1		1					1				3			6	33											
8.	3		1		3	1											3	3						1					
10.	1		2	2	4	3				1			1	1			5	1					5	2					
12.	2		3		3	2											10	2	1	1			6	3	2				
14.	1			1	5	7			1								9	3	1				1	2					
16.			2	1													2		4										
18. Bø	5		1		2				5	3							13	4		1	1								
19.	1				1	1			1		1			1			2												
20.	1		1		2	1			1	1							1												
22.	2		1						1		3						14	3	3	3							1		
24. Lunde			1														35	13											
26.	3				1					1							25	11	1										
	68	8	32	9	42	18			11	10	5		2	7			245	104	18	10	3	1	16	9	6		1		625
27.	4		1									4					35	12	8	2	1				1				
28.	5	1			1	1				1	2						6	1							1		1		
29.	9	3	3		2	3					1						31	7	4	1	3	1	7	1					
30.	1		1		4	2												1					3						
31.	2				4	3											11	9					3	1					
32.	1		1	3	8	2										1	47	7											
33.	3		1	1	3	2											26	3	3	1			1		1				
34.	2		3		4												8	2	2	1									
35.	3	1		1	2												12	5					1						
36.			1		4												12	1	1										
37.	1				1												4	1					1						
38.	2	1	7	2	11	8											21	9					5		4				
39.	1											1					1		2				1						
40.			4		1	1																							
41.	1	1	1		1												14	4											
	45	7	23	7	46	22				1	3	5				1	228	62	20	5	4	1	22	2	7		1		512
Second line.																													
50. Bø		1	1		2												1		2	2									
55.	2			1	2												4	1			1								
59.	4	2				1				1							3	4		2									
61.	3	2															6	2	1	3									
63. Seljord	9	2	2		2	1											17	14	2	2									
67.			6	2							1	1					56	4											
68.	3	2	2	1	6	1				1					1		22	8					1	1	1				
69. Kvitseid	8	1	2	1	1				3								7												
70.	1																14	4	4	5									
71.			1	2	7	4											17	5					4	1					
72.					6	2											3	1											
73. Vrådal	2		1		1					1	1						11	1											
75.			3		7	1											1	1											
	32	10	18	7	34	10			3	3	2	1			1		162	45	9	14	1		5	2	1				360

Table 16 b. The parasitic wasps emerged from the different samples in Telemark

	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
1953	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
27	10		3	1		1			1	1							26	7	7	2	1			2					
28	1								1					1		1	33	8	1						1				
29	7												2	1			33	6	3	1				1					
30	4	1	1	2					2					1			28	8	11										
31	9	2		1			2										45	13	7				1		3				
32	9	1	2	1									1	1			46	13	6										
33	12	2	1	3													27	18						1					
34	6	5	5	1			1						3	3			10	13											
35	8																22	4											
36	14	5	1						1				1				85	15	6		1		5	4	1		1		
37	16	1	3	1									1	1			32	5	4						1		3		
38	1	1	1		1							1					19	6	3				1						
39	19								1	2		1		2			71	5	2									1	
40	9	2		1						1			2	2			25	6	1										
41	6	2	1														21	6					1						
	131	22	18	11	1	1	3		6	4		2	10	12		1	523	133	51	3	2		8	8	6		4	1	961
1954																													
27	1		1														5	4											
28		1							3								6	5											
29																	10						4						
30		2															7	7							1				
31	10	2	8	1	2				3		1						35	8					2	1	2			1	
32		1							3								7	6					3						
33	2	1	3		1		1										9	2	2					2			1		
34	10	5							1								33	2			3								
35			1		1												14	5					2	1					
36	3			1								1					13	1	2									1	
37	3	1	3		1		1		1	1							8	3					2		2				
38	2	2	6	7		1			8								10	6	2								3		
39	1																1	5											
40	1																1	1											
41	1																5	9											
	34	15	22	9	5	1	2		19	1	1	1					164	64	6		3		13	4	5		4	2	375
1955																													
27	8	2			2				1			1					31	6					3	2				1	
28	1		1														9	3					3	3				1	
29	43	28	6	3	2				1								62	17					3	2			3	1	
30	7		1				1		1								23	2											
31	18	2			3	2			1								52	12			10			1					
32	11	2	1	1	2	1			1								32	12	1				9	5				2	
33	24	4	2	2			2		1								68	16	2		1		3	2	1				
34	50	8	2	3					1	2							34	12	1		21	3							
35	23	5		1					2								30	4		1									
36	15	4	1	2					2								24	2			1								
37	5	3																	1				3	1					
38	13	1	1	2													6	1			1		2	2				1	
39	39	9	5	2	1				1								41	17									3	1	
40	11		1	1													22	7	1										
41		1	1	1													6												
	268	69	22	18	10	3	3		12	2		1					440	111	6	1	34	3	26	18	1		6	7	1061
1956																													
27	7		1	1	4				3									1			1			1	1				
28	1																5	4					2	1				2	
29	6	3	2	1		2				1							18	15			1	3	2	2					
30	5	2	1		2	1			2	1							18	3					1						
31	3		3		1	3			1								20	2					1	1			1	1	
32	11	1	6	2	3				3						1		48	17					15	3	1		1		
33	14	3	1	1	2	2	2		1						1		117	35			1		3	2			1	1	
34	17	1	8	1													111	35			1	1	3	2			1	2	
35	32	10	13	4	1				2				2	1			113	68	1		3	2	9	5	4		6	5	
36	33	8	24	17		1											152	34			2	1	1					1	
37	36	6	7	2													43	6			3								
38	2																6	1									1		
39	1	1	9	3											1		19	3					4	2	1		1		
40	2								1								3	2											
41	7								5								12	11					1						
	177	35	75	32	13	9	2		18	2			2	1	3		685	238	1		12	7	42	19	7		12	12	1404

Table 17. The parasitic wasps emerged from the different samples in Trøndelag.

	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
1954																													
101.	1	1							1		2	2	6	5															
102	1	1							5		7	4	5	5			13	2					1					2	
103	1	1	2	1					5	1			2	2			10	2											
104	1								8	1	6	10	2				3												
105	1		2						8		7	14	1	4		1	22	10	2									3	
106	2	2	1						6	1		1					14	1											
107	2	2							5	1			3			1	56	31											
108			2	1							1		2	3			30	32									2	2	
109			1								2		1	7			9	4											
110	1		1						2		1		1	3			15	6	1									2	
111		1	2						2		2	1	1	4			19		1								1	2	
112	4	1	18	11					1		1	2	1	1	2		83	73	2										
	14	9	29	13					43	4	29	34	25	34	2	2	274	161	6				1				3	11	694
1955																													
101	1		1									1	4	5		1	4	5											
102	1	1		1					4		7	3	2	1	1		3	1											
103	1	1	1	1					12	5			3	3	1	1	10	3									6	2	
104	2	2	1						8		8	31			2		3	1											
105	9	1	13	19					42	8	9	15		1	1	1	15	8									8	7	
106	4		1	2					4	1	1		1	1			5	5											
107	2								1		7	3					20	1									1	2	
108	5	2	3	1					11	7	4	3	1		6	8	24	8									17	14	
109	8	3	8	6					24	5	2	1	3	7	5		9	4	1	1							14	9	
110			5	1					32	7	2			1	1		4	5									5	1	
111	2	2	9	17					9			1		3	2	1	44	26									2		
112			1	1							1	1	1	1			12	13											
	35	12	43	49					147	33	41	59	15	23	19	12	153	80	1	1							53	35	811
1956																													
101											2	3					3	1											
102			1						4		1	2		1															
103	6	3	1						2								2	1											
104	3	1	2	1					17		1	1					5	9										2	
105	3		1	1					9	1	3			1			10	3					1				1		
106	1								1		2	2						2										1	
107	1		1														3	1									3		
108	10	6	2						30	2							3	2									3	5	
109				1					10	3	1			1		1	1	1									1	2	
110	4								11	1		1		1													1		
111		1		1					3	1					1	1	1												
112	7	10	5	9					5	3	3	1	1	2		1													
	35	21	13	13					92	11	13	10	1	6	1	3	28	20					1				9	10	287

Table 18. The succession of the emergence of the different species

Trøndelag	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
1955	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
22/7			1	7					4	2			1	1			1												
23/7			1						4																			1	
24/7				1					1			1		1															
25/7	4	3	4	23					23	1	4	12	2	3	1		3	3		1									
26/7	1	1		3					12	4	3	10	1	3	4	1	1	2											
27/7	1								9					1	2		1										5	4	
28/7	4	3	5	10					9	2	2	1	1	2	1	4	1	2									5	6	
29/7																													
30/7	1		4	4					6					1	1		30	11									2	2	
31/7																													
1/8	1	1		1					7		6	3	4	2	1	1	5	1									4	2	
	12	8	15	49					75	9	15	27	9	14	10	6	42	19		1							16	15	342

Table 19. The parasitic wasps from areas with small population only of Phyllocnistis labyrinthella.

	Cir. vit.		Cir. pict.		Cir. elegant.		Cir. subv.		Eulop. pect.		Eulop. long.		Eulop. stram.		Symp. sericei.		Epil. tad.		Epil. gunholdi		Epil. mirab.		Clost. trifasc.		Tetrast. xanth.		Tetrast. femor.		
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	
1954																													
Nelaug I	1								1	1							11	2					2	2					
» II	6	2	1		2	1				2		2					33	9	1										
» III	3	1	1		2	5							1	1			7	5					1				1		
Arendal I	1		1														11	8					3	1					
» II	1				1	1											19	9	1				4						
	12	3	3		5	7			1	3		2	1	1			81	33	2				10	3			1		168
1955																													
Nelaug I																	1	1					1						
» II	1																												
» III																							1						
Arendal I																	7	1											
» II																	2												
	1																10	2					2						15
1956																													
Nelaug I		1	1	1					1								20	3											
» II	5	1	4		4	1			1								10	5					3		1				
» III			1		4				1								9	4					1						
Arendal I	1			1	1												8						6	1					
» II																	6	1					1						
	6	2	6	2	9	1			3								53	13					11	1	1				108

Table 20. The changing of the host. The result of the experiments

	The females emerged from:				Oviposition on:				Feeding on:				Admittance to:				Time from admittance to oviposition	Duration of experimental period	Remarks
	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.			
Cirrospilus vittatus	×				×	×			×	×	×	×	×	×	×	×		30	
— —	×				×	×			×	×	×		×	×	×			24	
— —	×										×			×	×			27	
— —	×										×				×			20	
— —			×		×				×				×					32	
— —			×		×				×				×					16	
— —			×		×		×	×	×		×	×	×		×	×		18	
— —			×								×		×		×			26	Adm. to Ph.lab. 1 day only
Cirrospilus pictus	×				×	×	×		×	×			×	×	×			30	
— —	×				×		×	×	×		×	×	×		×	×		18	
— —	×				×	×			×	×			×	×				25	
— —	×				×		×						×		×		17 days. Ly. cl.	27	
— —	×						×				×				×		12 —	20	
— —	×				×				×		×		×	×	×			24	
— —	×				×		×	×	×		×	×	×		×	×		46	
— —	×							×				×				×		3	
— —	×							×				×				×	1 day ovip. Rh.	14	
— —	×				×	×			×	×	×		×	×	×			32	
— —	×											×			×	×		15	
— —			×		×	×	×		×	×	×		×	×	×			28	
— —	×						×			×	×			×	×			15	
Cirrospilus elegantissimus	×				×				×				×	×				38	
— —	×				×				×	×			×	×				18	
— —	×				×	×			×	×			×	×			28 days. Ph. l.	40	
Cirrospilus subviolaceus ..	×				×				×				×	×				33	
Eulophus pectinicornis ...	×				×				×		×		×		×			18	
— — ..	×				×	×	×		×	×	×		×	×	×			33	
— — ..	×						×			×	×			×	×		16 days. Ly. cl.	23	
— — ..	×						×	×	×		×	×	×		×	×	5 days. Rh.	37	
— — ..	×				×				×		×		×		×		6 days.	6	
— — ..	×								×		×		×		×			18	Ph. lab. 3 days only
— — ..					×				×				×				8 days. Ph. l.	23	
Eulophus longulus	×				×		×		×		×		×		×			24	
— —	×				×	×			×	×			×	×			3 days Ph. l.	34	
— —	×						×				×				×	×		13	
— —			×		×				×				×				3 days.	15	
— —			×		×				×		×		×		×		3 days.	20	
— —			×		×				×				×				9 days.	9	
— —			×		×		×		×		×		×		×		1 day.	14	
— —			×		×		×		×		×		×		×			18	
— —			×		×				×				×					12	
— —			×		×		×		×		×		×		×			14	
— —			×				×				×		×		×		3 days.	31	Ph. l. 2 days only

Table 20.

(Cont.)

	The females emerged from:				Oviposition on:				Feeding on:				Admittance to:				Time from admittance to oviposition	Duration of experimental period	Remarks
	Ph.l.	Ph.s.	Ly. cl.	Rh. pop.	Ph.l.	Ph.s.	Ly. cl.	Rh. pop.	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.	Ph.l.	Ph.s.	Ly.cl.	Rh. pop.			
Closterocerus trifasciatus .	×				×	×			×	×			×	×			0 days.	18	
— —	×					×				×	×			×	×		28 days. Ph.Ly.cl.	36	
— —	×							×				×	×			×	8 days.	13	Ph. l. 1 day only
— —	×											×				×		12	
— —	×									×	×		×	×	×			26	Ph. l. 2 days only
— —	×				×				×	×			×	×				32	
— —				×	×				×			×	×			×		12	
Epilampsis tadici	×				×	×			×	×			×	×			5 days. Ph. l.	39	
— —	×				×	×			×	×	×		×	×	×			28	
— —	×				×		×		×		×		×		×	×	24 days.	28	
— —	×				×		×	×	×		×	×	×		×	×		26	
— —	×						×				×	×			×	×		3	
— —	×								×				×		×			15	
— —			×		×				×				×				4 days.	16	
— —				×	×				×				×				0 davs.	12	
— —				×	×				×				×				1 day	3	
Epilampsis gunholdi			×		×				×				×				1 day	3	
— —			×		×	×			×	×			×	×			1 day.	10	
— —				×	×				×				×					6	
— boops				×	×				×				×				5 days.	6	
— —				×					×				×					7	
Tetrastichus xanthops....	×				×	×			×	×			×	×			1 day.	31	
— femoralis .	×				×		×		×		×	×	×		×	×	9 days.	15	
— —	×				×				×	×			×	×			7 days.	34	

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