Contributions to the Life History of the Pimpline Spider Parasites (Polysphincta, Zaglyptus, Tromatobia)

(Hym. Ichneum.).

By

E. Nielsen.

In commemoration of the late Dr. phil. J. C. Nielsen.

Preface.

Originally it was in contemplation that our well known hymenopterologist (and dipterist) Dr. J. C. Nielsen, later on deceased, should have treated the material underlying this investigation. I brought him the first spider I took here in Denmark infested with an ectoparasitic Polysphinctid larva, upon which he asked me to gather material just of that kind, as personally he had never succeeded in finding anything like that and he was very interested in discovering how the larva held fast on to the host.

Consequently, one day in the spring, I went to the grand deer-park „Dyrehaven" North of Copenhagen, where I took a dozen specimens of *Theridium lunatum* and *Cyrtophora conica,* all infested with larvae. It should however not be my fortune to see Dr. Nielsen's satisfaction in my capture nor the result of his ingenious faculty for finding out the secrets in the life of small insects: a letter which I received from his wife the next morning, informed me of the mournful fact that he had departed his life. Therefore I was forced to do the investigation myself, but remembering the interest Dr. Nielsen always took in my investigations and his hearty manner of helpening me, I dedicate these pages, containing my results, to the memory of Dr. Nielsen, under feeling of deep sadness of his premature mortal exit.

The first imagines reared by me were determined by Prof. Dr. O. Schmiedeknecht (Thüringen). Later on Dr. A. Roman (Stockholm) has had all my material for determination and revision, and the names used in the following are due to his determinations.

Mag. sc. R. H. Stamm, lecturer at the Copenhagen University, has made the cuts underlying a part of this investigation, and mag sc. Kai L. Henriksen, Zoological Museum has helped me gathering litterature and in several other ways.

The drawings are performed mainly by Mr. Thydsen-Meinertz, some few by Mr. Aage Larsen and Mr. Th. Mortensen, all municipal teachers of Copenhagen.

I am greatly indebted to all these gentlemen, for their excellent assistance, for which I thank them most sincerely.

I also thank Mr. J. P. Kryger who furnished me with a material of parasitized *Epeira Redii,* and Mr. O. Bakkendorf whose observations as to *Polysphincta pallipes* I was allowed to use.

I have presented the Zoological Museum, Copenhagen with my material, which is now to be seen there.

I owe a debt of gratitude to the Rask-Ørsted fund which has subsidized the publication of my investigations in the present form.

Introduction.

The present paper deals mainly with the biology of the ichneumon fly genus *Polysphincta* which belongs to the family *Ichneumonidae* and within this to the sub-family *Pimplinae.*

The genus *Polysphincta* was erected by Gravenhorst (Ichneum. Eur. III 1829 p. 112) for the species *tuberosa, rufipes, varipes, multicolor, percontatoria* and *carbonator,* most of which were then new to science and described by Gravenhorst himself. Only *percontatoria* was previously known, as described by O. F. Müller in 1876.*)

Later on Förster (Verh. naturh. Ver. preuss. Rheinl. XXV 1868 p. 166) divided the genus in four parts viz.

*) Gravenhorst was not aware that also *I. aranearum* De Geer (described 1783) must be referred to the genus *Polysphincta.*

Zaglyptus Först., *Polysphincta* Grav., *Acrodactyla* Hal. and *Zatypoda* Först., which all he considered to be of generic rank.

Schmiedeknecht, however, in his Opuscula Ichneumonologica XV 1907 p. 1160, states that the Försterian names can only mean subgenera, and that all the species registered under the said names must be regarded as belonging to one genus, the old *Polysphincta.*

Morley in his Ichneumonologia Britannica III Pimplinae 1908 p. 118—134 puts fort the English species in two genera viz. *Polysphincta* and *Acrodactyla,* thus uniting *Zaglyptus* and *Zatypoda* with the former.

Habermehl (Zeit. wiss. Insektenbiol. XIII. 1917 p. 167) considers the species *eximia,* described by Schmiedeknecht, to form a separate genus, which be calls *Polysphinctopsis,* a separation which, as will appear from my descriptions below, has no biological support, and according to Dr. Roman (see the following paper) nor any morphological one.

The latest systematical worker upon the Pimplins W. Hellén (Acta Soc. pro Faun. et Flor. Fenn. 40 No. 6 1915) unites *Zatypota* and *Polysphincta* as subgenera of the genus *Polysphincta,* while *Acrodactyla* just as in Morley is considered to be a separate genus, both genera belonging to the subtribus *Polysphinctini,* while *Zaglyptus,* likewise considered as a separate genus, is placed in quite another subtribus viz. *Epiurini,* near the genus *Tromatobia* which latter was erected by Förster 1868 and includes a. o. the 2 species *ovivora* and *oculatoria* both like *Zaglyptus varipes* living in spiders' egg cocoons*), and formerly placed in the old genus *Pimpla.*

In the present paper I deal with all the spider parasites belonging to these genera known to me.

In litterature not a few remarks are found concerning the biology of the genus *Polysphincta,* which, however,

*) The 3 other species of Zaglyptus all live as external parasites on spiders.

with a single exception give but a most incomplete knowledge of the life history of these interesting little animals, during their developmental stages from egg to imago, being for the most part confined to a statement of the host and the developmental dates. The very few more extensive statements can be seen in Morley: British Ichneumons III.

In the list set out below all the cases known to me are specified, where a *Polysphincta* s. l. is recorded as reared from a known host, viz.*)

1. *P.* (*Zatypota*?) *aranearum* Retz.**) – Host: Undetermined orb-spider (De Geer Mem. II p. 863, pl. XXX fig. 1–3.)
2. *P. albipes* Cress. – Host: Undetermined Lepidopterous larva (Howard: Insect Life I 1888 p. 43).
3. *P. areolaris* Ratz. – Hosts: Hymen.: *Trichiocampus viminalis, Croesus septentrionalis* (Ratzeburg: Ichneum. d. Forstins. I 1844 p. 120; III 1852 p. 111).
4. *P. (Polysphincta) boops* Tschek. – Hosts: Arachn.: *Theridium sp.* (Brischke: Deutsch. Ent. Zeit. XXI 1877 p. 285), *Epeira diadema*ta (Morley: Ichn. Brit. III 1908 p. 120).
5. *P. (Polysphincta) carbonator* Grav. – Hosts: Arachn: *Meta merianae* (Epeira antriada) (Blackwall: Ann. Mag. Nat. Hist. XI 1843 p. 2.; nom. err. carbonaria), *Epeira diadema*ta (Boie: Stett. Ent. Zeitg. 1846 p. 292), *Epeira dromedaria* (van Hasselt: Tijdschr. voor Ent. XXXIV 1892 p. 38), *Epeira cucurbitina* (Snellen van Vollenhoven: Tijdschr. voor Ent. XIII 1870 p. 17–19), *Linyphia pusilla* and *Leptyphantes minutus* (Blackwall: Brit. Assoc. Rep. 1842 p. 68), *Steatoda borealis* (Howard: Insect Life I 1888 p. 42), undetermined spider (Habermehl: Zeit. wiss. Insektenbiol. XIII p. 167) „Spinneneier" (Ratzeburg: Ichneum. der Forstins. II 1848 p. 101, III 1852 p. III); Hymen.: *Nematus ventricosus* (Brischke teste Morley), and „aus angeschwollenen Zweigen von Populus tremula mit *Saperda populnea*" (Boie: Stett. Ent. Zeitg. XVI 1855 p. 103).
6. *P. (Acrodactyla) degener* Hal. – Hosts: Arachn.: *Linyphia obscura* and *zebrina* (Cambridge: Spiders of Dorset II, p. 579), *Linyphia obscura* (Bignell: Trans. Devon. Assoc. 1898, p. 471), *Linyphia*

*) the species names are those used in Dalla Torre: Catalogus Hymenopterorum.

**) perhaps identic with *picticollis* Thoms. (comp. Roman p. 206).

phrygiana (Adlerz: Entom. Tidskr. XXXI, 1910, p. 100), undetermined small spider (Parfitt: Trans. Devon. Assoc. 1881, p. 41).

7. *P. (Polysphincta) dictynæ* Ril. – Host: Arachn.: *Dictyna volupis* (Howard: Insect Life I, 1888, p. 107).
8. *P. (Zatypota) discolor* Holmgr. – Reared from a cocoonous web on a leaf (Habermehl: Zeit. wiss. Insektenbiol. XIII, p. 167).
9. *P. elegans* Ratz. – „Aus Buchenkloben mit Anobien und Ptilien" (Ratzeburg: Ichneum. d. Forstins. II 1848 p. 101).
10. *P. (Zatypota) gracilis* Holmgr. – Hosts: Arachn.: *Epeira cucurbitina* and *Meta segmentata* (Bignell: Entom. 1882 p. 173).
11. *P. (Zaglyptus) kincaidii* Ashm. – Host: Arachn.: *Tetragnathus sp.* (Ashmead: Insect Life VI 1894 p. 260).
12. *P. (Zaglyptus) koebelei* How. – Host: Arachn.: *Epeira strix or sclopetaria* (Howard: Proc. Ent. Soc. Washington 1892 p. 293).
13. *P. latistriata* Ratz. – Reared from the mines of *Orchestes quercus* on oak leaves (Ratzeburg: Ichneum. d. Forstins. I 1844 p. 120).
14. *P. lignicola (?)* Ratz. – Host: Some Cerambycid beetle (Ratzeburg: Ichneum. d. Forstins. III 1852 p. 110).
15. *P. (Zaglyptus) multicolor* Grav. (= fairmairei Lab.). – Hosts: Arachn.: *Clubiona holosericea* (Laboulbène: Ann. Soc. Ent. France (3) VI, 1858, p. 807), *Meta Merianae* and *Epeira cucurbitina* (Morley: Ichneum. Britann. III, 1908, p. 126).
16. *P. (Zatypoda) percontatoria* Müll. – Hosts: Undetermined Arachnid egg-cocoon (Kryger: Entom. Meddel. (2) III p. 262 a. 272), larval case of *Fumea casta,* „which more probably had been tenanted by a spider" (Morley: Ichneum. Britann. III 1908 p. 130).
17. *P. (Zatypota) picticollis* Thoms. – Host: Arachn.: *Theridium lunatum* (Karsch: Entom. Nachr. XXIV 1898 p. 349).
18. *P. (Polysphincta) pulchrator* Thoms. – Host: Arachn: *Theridium varians* (Karsch: Entom. Nachr. XXIV, 1898, p. 348).
19. *P. ribesii* Ratz. – Host: Hymen.: *Nematus ribesii* (Ratzeburg: Ichneum. d. Forstins. III, 1852, p. 110).
20. *P. (Polysphincta) rufipes* Grav. – Host: Undetermined spider (Brischke. Schr. naturf. Ges. Danzig N. F. IV p. 114. Epeira diademata teste Morley).
21. *P. soror* Ratz. – „Aus Buchenkloben mit Anobien und Ptilien" (Ratzeburg: Ichneum. d. Forstins. II 1848 p. 101).
22. *P. (Zatypoda) strigis* How. – Host: Arachn.: *Epeira strix* (Howard: Proc. Ent. Soc. Washington, II, 1892, p. 291).
23. *P. (Zatypota) theridii* How. – Host: Arachn.: *Theridium sp.* (Howard: Proc. Ent. Soc. Washington II 1892 p. 292).
24. *P. (Polysphincta) tuberosa* Grav. – Hosts: *Epeira cucurbitina* (Vollenhoven: Tijdschr. voor Entom. XIII 1870 p. 17–20. Bignell:

Entomologist XV 1882 p. 174), *Epeira adianta* (Bertkau: Ber. wiss. Leist. währ. 1881 p. 212), *Cheiracanthium carnifex* Kryger: Entom. Meddel. (2) III 1910 p. 262, 270, 272. – nom. err. P. varipes).

25. *P. (Zaglyptus) varipes* Grav. – Host: Arachn.: *Cheiracanthium carnifex* egg cocoon (Kryger: Entom. Meddel. (2) III 1910 p. 262, 270, 272).
26. *P. velata* Htg. – Host: Lep.: *Fidonia piniaria* (Hartig: Jahresb. Fortschr. Forstw. I P. 2. 1838 p. 262).
27. *Pi. (Tromatobia) oculatoria* F. – Host: Arachn.: *Epeira diademata* – egg cocoon (Laboulbène: Ann. Soc. Ent. Fr. (5) I. 1871 p. 444. Morley: Ichneum. Britann. III, 1908 p. 114, undetermined spider's egg cocoon (Gravenhorst: Ichn. Eur. III 1829, p. 154. Morley l. c. p. 114).
28. *Pi. (Tromatobia) ovivora* Boh. – Hosts: Arachn.: *Epeira* egg cocoon (Taschenberg: Zeit. Ges. Nat. 1863 p. 265. *Lathrodectes tredecimguttatus* egg cocoon (Telesphore: Pet. nouv. entom. II 1878 p. 266). Undetermined spider's egg cocoon (Boheman: Sv. Akad. Handl. 1821 p. 336. Brischke Schr. phys. ökon. Ges. Königsberg V 1864 p. 184*). Ratzeburg: Ichn. der. Forstins. III p. 102. Taschenberg: Zeit. Ges. Nat. 1863 p. 265.). Hym: *Nematus septentrionalis*-larva and *Lophyrus ? frutetorum* larve (Ratzeburg ibid. p. 102). Lepid.: *Geometra alniaria or tiliaria* (Ratzeburg ibid. p. 102).

A view of this list will show that the greater majority of the species is reared from spiders, and spiders must thus be considered to be the ordinary hosts for the Polysphinctas; most of the species live, as the different agreeing statements show, as external parasites on the spiders themselves, ectoparasitism thus being the normal economy of the larvæ, only very few species having confined themselves to life in the spiders' egg cocoons.

Certainly, more species, especially those reared by Ratzeburg and Hartig are recorded from larvae of beetles, plant wasps, and moths, but partly we must doubt that the host statement in all cases is correct, partly it is by no means certain that the species described by the two mentioned autors should really belong to the genus

*) the determination „von Teridium?" must be erroneous.

Polysphincta in the present sense of this genus. Thus Morley stated (l. c. p. 119) that *P. elegans* is identic with *Clistopyga incitator* F., *P. areolaris* most probably the male of some Tryphonid, and other species in question also quite doubtful as belonging to Polysphincta.

As long as all species of Polysphincta have not yet been reared we must however confess that the habits of the genus has not been quite difinitely ascertained, and it is thus still uncertain whether all species will prove to be parasitic on spiders or whether hosts of such systematical diversity, as recorded, can be found within a little group as the Polysphinctas — though the former is most likely the case, as all Polysphinctae, about whose systematical position within the genus no doubt can be raised, and whose hosts are known, all are spiders' parasites.

This uncertainty must be ascribed i. a. to the fact, that infested spiders are met with very seldom in nature. As I have had the good fortune to find several localities where rather a considerable number of spiders of different species have been hosts of the larvae of the said parasites I have however been able to follow the life history of more species of these latter, and I shall now account for the results of my researches.

1. **Polysphincta eximia** Schmk.

Polysphincta eximia whose host has not till now been known, lives in the larval stage as an external parasite on the Theridiid spider *Theridium lunatum* (Th. formosum).

The eggs have been fixed on the abdomen of the spider, near the petiole between the cephalothorax and the abdomen. Here the larva has its base of attachment, and here it remains until it is developed and is going to pupate; the spot, where the egg has been placed, is well concealed, and the tender larva is hardly to be seen with the naked eye; in fact, during its first life-time, it will be sitting, as it were, behind a screen, because in

the position of rest the legs of the spider are drawn close to the body, the femora slanting in over the same. During the growth the larva stretches over the abdomen of the host, always arching more and more. It is the hind portion of the larva, that is fixed to the host; the foremost part is pushed forward more and more away from the point of fixture.

As usual in case af larvae of Ichneumonidae the body of the larva is, apart from the head, divided into thirteen segments. The last larval stage has an unpaired dorsal row of warts or protuberances in a number of eight, placed on the 3d to 10th segments in the middle line. The two foremost and the three hindmost segments have no such warts.

On the ventral side of 8th and 9th segment there are, besides, found four taps or processes, a pair of which on each segment. The form of these taps is variable, now blunt, now tapering, but upon the whole they are weak, clear and hardly distinguishable with the naked eye.

On all the body segments are found rather scanty hairs, placed circularly round the segments; they are short and delicate, and not very conspicuous, even under high magnifying powers; only on the hindmost segments they are longer, and somewhat bristling, though thin and clear.

In the last larval stage we furthermore observe some dark chitinized spots; they are found on the lateral surfaces of 2d and 3d segments and on the ventral surface of the first three segments. They will indicate the spots where wings and legs are formed by the imaginal discs; while the skin of the larva otherwise is pellucid, the imaginal discs thus are concealed under these dark shields.

The most interesting of these different appendages and features are the dorsal warts. When seen through a lens such a wart will bear a certain resemblance to the stigma of certain flowers. It is sagittally slightly bisected,

the upper part thus consisting of two slender protuberances; the median furrow often shows a branch on each side, thus appearing cross-like. Through a lens you can see the upper surface of the protuberances covered with something like dark grains, which seen through the microscope prove to be fine hooklets strongly bent, all

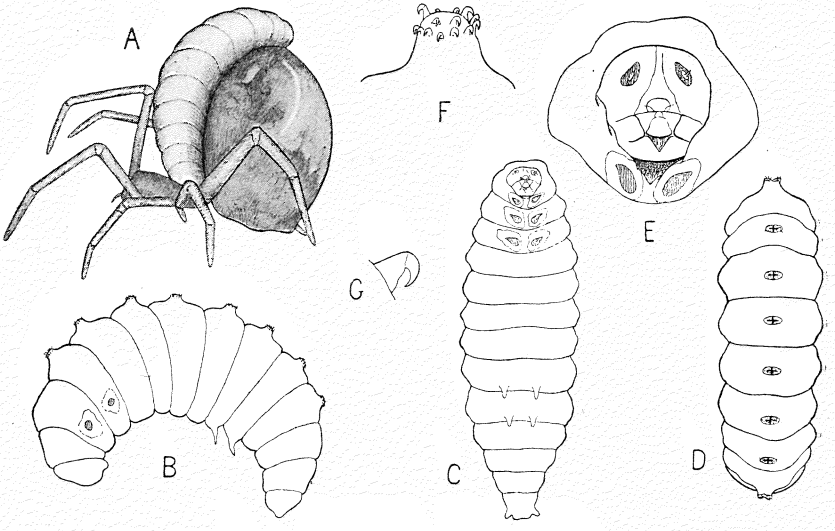


Fig. 1. *Polysphincta eximia* Schmdk.

A Larva (in penultimate stage) in its normal position on the back of Theridium lunatum. B, C, D Larva in the last stage, seen from left side, from below and from above, showing the 8 dorsal warts, the 4 ventral taps and the dark spots covering the imaginal discs. E Head and Prothorax seen from in front. The side parts of head hidden in the latter. F A dorsal wart, seen from the side. G A hooklet greatly magnified.

of them turned outwards i. e. with the convex side towards the centre of the wart.

The larva can retract the warts as to make them disappear from view; each half can be retracted separately, only, however, so that if one half is lowered, the other one will take a slanting position with its surface inclining towards the place of retraction. These warts set with

hooklets form an extremely fine and ingenious mechanism, which serves the animal for legs, holding it fast to the web, in which the spider has been living, when, at its last stage, the larva kills its host. At the said stage of development the larva, unless being possessed of these warts, would hopelessly fall to the ground; but the warts are like hands that are now clenched, now opened, the retracting meaning the clenching and the protruding the opening of the hand. In this way the larva endeavours to catch the threads of the spider's web as to make stick in the hooklets, even if the wart is pushed out; but if it intends earnestly to hold fast, then it will retract the warts as to conceal the hooklets together with the threads and submerge them totally in the body of the larva. Now the grasp of the web cannot fail.

On the 2nd of June (1918) I was observing a larva which had performed its last moulting and, consequently, was furnished with the warts above mentioned. Previous to its having left the dead remains of its host, I detached it from those, after it had itself freed its hind end. At that time the ventral side of the larva was highly viscid. Freed from the host the larva was laid on its back in a narrow cork-groove, where it lay in an arched position, head and hind end upwards. Placed in this position under the microscope it at once began to bend its head and its hind end quite towards each other; it seemed to be going to cover its hind end with threads, as it performed spinning-like movements with its head. The hind end was very much extended, and the long, fine and clear hairs of the hindmost segment were bristling laterally. — A peculiar feature was, that warts bluntly tapered were pushed out from the sides of the hind end, which warts, however, were visible only for a few moments at a time. It looked to me, as if the larva intended to hook on its thread to the hairs of the hind end and to the warts pushed out from this. But no thread appeared

during those spinning movements: the larva had got its spinning instinct a little too early i. e. before the spinning capacity had appeared.

This first examination of the larva had lasted on from 5 to 7 o'clock a. m. At 4 o'clock p. m. the animal was again taken out, and now it had surrounded itself with a fine network. This was picked off, which was no matter of ease, partly because this surrounding tissue (the beginning of the pupal cocoon) was tenacious, partly — and that particularly — because it was held fast by the hooklets of the warts of the back.

Being disengaged from the cocoon the larva proved able to move to and fro in the tissue, which was performed by means of the back-warts, which were pushed in and out; they looked like hands grasping and releasing their hold; but also the hind end was helping the thing along; it was braced against the threads, which it seemed to grasp. During the movements forwards and backwards the larva was constantly arched and did not advance more than a few millimeters.

Having been disengaged from the cocoonous tissue the larva was once more placed in the cork-groove and put under the microscope, where the spinninglike movements were reiterated over the hind end now again quite extended: upward along its sides, round its two warts, and quite below it, and now the spinning glands were in action.

I have already remarked, that the hindmost segments of the larva are furnished with proportionnally long hairs, which are somewhat bristling. It is quite evident that these long hairs at the hind end bear upon the founding of the larva's cocoon.

The next day, in the morning, I held in my hand a tube containing the host and the parasite, which I regarded under a lens. Contrary to custom the larva — which was at the last stage but one — was uneasy, and the

spider rushed about in the glass like one possessed. Only for a few moments at a time she stopped her run, and each time I gave my whole attention to the point of fixture between the spider and the larva in order to see the stability of the connection. For a long time the hind end of of the larva lay as usually, nailed or adhering on the body of the host, but the front part rose from its couch, tossing abruptly from one side to the other. At last it seemed, that also the hind end had lost its hold of the spider: it was, just as the front part, cast to the sides, and now it became evident, that the close connection between the two animals was neither by the head nor by the hind end, but somewhat anteriorly the latter. Once, when the front part of the body was rather much elevated, it seemed to me to have a peculiar black spot on the bottom just behind the head: this was painted over with dark lines, and suddenly the head had turned intensely yellow. Now the black spot slid slowly more and more to the rear on the ventral side of the larva — it was the skin of the head, the animal was moulting! And now! Suddenly, a wart shot up above, by which it was further ascertained, that an ecdysis was taking place. A moment after another wart was seen to come forward, and I believed to see under the skin those of the warts, which were not yet disengaged, as if they were working at forcing back the skin. In contracting and extending its body the larva made its way out of the skin, which burst wart by wart, as these came forward one by one in a row from the head. All this, I think, lasted one quarter of an hour. On the sides, quite near the bottom the exuvium was seen though indistinctly. Even half an hour after the moulting the hind end had not calmed down. During the whole moulting process it was quite obvious, that the part of the larval body which was most intimately attached to the spider was not the last segments of the body. In my opinion, however, the repeated attempts

at fixing made by the hind end indicated in a way not to be mistaken, that also that part of the body bore its part, though no very important one, as to the fixing question. Perhaps this part should be understood in view of the arched form of the body of the larva. The said arch is hardly to be straightened, and when it is again set free the larva will immediately resume its arched position. If now the larva is lying over the spider's back, in firm connection with this through the median part of its concave underside, its body will spontaneously press against that of the host with a certain degree of force. This very fact is a factor as to the adhering capacity of the larva; owing to the small side of the arch also this factor however becomes small, but it increases together with the larva.

If a larva adhering to a spider is keenly observed along its underside a small plate somewhat anteriorly to the hind end, will be seen. The plate consists of the exuviæ from the younger larval stages, which form a saddle adapted to the body of the larva and whose nethernmost (oldest) layer on a certain spot is intimately glued to the skin of the host. If you attempt at looseing a larva from the spider, after both of them have been killed, you will succeed therein rather easily, but the saddle will still adhere to the larva. Several times I have tried to sever the living larva from the small plate, but in every case without success, the result having always been, that the larva was hurt. On the other hand, if the larva has performed its last moulting having totally sucked out its victim, it will leave the latter, and then the plate (the small saddle) wil be left on the dead host, still adhering to this.

It can be noted that a similar mode of connection between host and parasite is found with the larva of the goat chafer, *Rhizotrogus solstitialis* and its parasite, the larva of *Tiphia femorata.* This latter rests on a plate, which after

each moult becomes broader and bigger, as each skin cast off forms a new flake upon the old one, while the part resting immediately on the host consists of the egg-shell (Bergsøe a. Meinert).

As well the larva of *Polysphincta* as that of *Tiphia* are external parasites, destitute of limbs and other fastening organs, but living upon a host, that is alive and in full activity in order to support life. Such a larva dare not

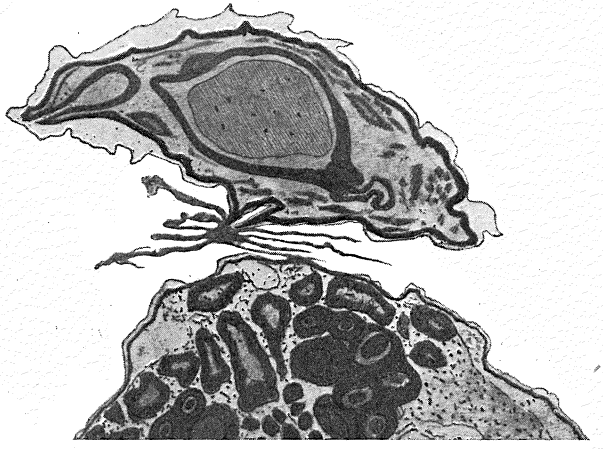


Fig. 2. Longitudinal section of a *Polysphincta eximia* (above) fixed to a *Theridium lunatum* (below). 38 × enlarged.

loosen its fastening while moulting, as in doing so it would unavoidably drop off and perish. It is the very condition of its being, to be allowed literally to rest on its own cast off clothing.*)

The part of the body of the *Polysphincta*-larva, that

*) It must however be granted that not all external parasitical Hymenopterous larvæ are fixed to the host through their exuviæ. Thus the larva of the Pompilid *Salius sanguinolentus* is not in any way firmly connected with its host, the spider *Cheiracanthium carnifex*, but it does not need such at firm fixing as the host does not leave its nest during the development of the larva.

rests in the saddle, is furnished with four taps, those mentioned above in the description of the larva, and it is thus the eighth and ninth segments that rest in the saddle. The said taps are very delicate and difficult to be seen without microscope.

Are we here in the face of the fastening apparatus of the larva? Undoubtedly; but the connection between the taps and the saddle cannot be ascertained through direct observation, and it has thus proved necessary to study their correlation in cuts.

We might believe, that the taps either were implanted in the skin of the spider or would show the opening of some glands through the secret of which the host and the parasite were glued to each other. But the cuts showed, that both suppositions fall short of reality. The taps do not penetrate the skin of the spider, nor do they contain glandular cells.

Of what avail are these taps to the larva? their being found just where the larva is fixed to the host, seem to preclude the possibility of their serving no purpose. We shall try through a view of the larva to clear up the matter. We then imagine the larva going to cast off the skin in the manner above described. It is worth noting the restlessnes and the violent movements. The organic connection between the skin and the individual is broken by the moult, and if now the larva were smooth on the ventral side, without any submersions in the old flakes, it would certainly be difficult to the larva to „keep the saddle". But now the skin cast off will stick round the taps, and in spite of the failing organic connection with the old skin the larva will be prevented from dropping off. On this basis the question now put forth can be answered to the effect, that, by means of the taps, the larva is allowed to cast off the skin without loosing touch with the host; they bring about touch between the

larva and the saddle, and as the saddle adheres to the spider, they also bring about contact with the latter.

Now, could not one single tap have produced the same consolidated fastening? Scarcely, which may be understood from a comparison with a board fixed with nails. As long as only one nail is driven in, the board can be turned; if there are two, it can tilt up, only after the third one has come to, without being in a line with

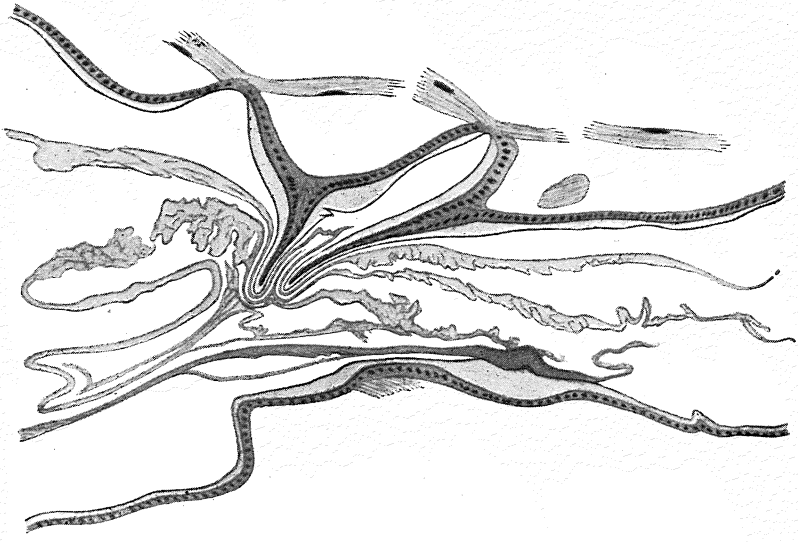


Fig. 3. Central part of the cut showed in Fig. 2, c. 150 × enlarged. The ventral taps and the cast skins lying between the Polysphinctid larva (above) and the spider (below).

the other ones, the board will be safely fixed. And this is also the case with the larva which is fastened by means of four „nails", placed in two lines.

The fact, that the „nails" are not placed on the hindmost segment of the body, further contributes to making safe the connection.

We have here spoken of the larva in its ultimate stage as to the ventral taps and the plate beneath the

larva. But the cuts show, that the taps are just as useful in the previous stages; only in the very first stage of the larva, when it has no skin to which to cling, there is a point of time, where the taps surely must to be out of action, if they exist at all at that time. It is, however this first skin, which is glued to the host, forming the basis for the other subsequent ones. Consequently, the taps of the second stage larva must have such a hold of the said first skin, that the larva does not drop off when moulting first time. But how this hold is performed, cannot be seen from the cuts.

Even if, under normal warmth and food conditions, the growth of the larva is rapid, it may occur now and then, that the larva has not completed its development, when the spider is going to moult. I had about 50 specimens of *Theridium lunatum* in tubes separately, each with a larva on its back. One of the spiders cast off its skin previous to the larva being fully developed; notwithstanding the larva kept its seat on the spider. I dared not fully rely upon this experiment, until the cuts of another specimen seemed to show, that the undermost flake of the plate actually originated from the spider and consequently bore witness, first, that the larva can hold on upon the spider in spite of the said moulting, secondly, that also this spider had cast off its skin with the larva sitting upon it. Probably, there is no other explanation than supposing, that the substance secreted by the tender larva, penetrates the skin of the host, which is thereby glued to the new skin beneath. Or perhaps the connection is performed through the wounds inflicted upon the spider by the sucking larva?

As the spider lives its whole life in its web, the larva too is under the necessity of living its life there, dependent as it is on its host. But the larva lives in the web not only in its larval stage, also the stage of pupa is passed there, an immediate consequence of the slight

mobility of the larva. Well! the larva is no mobile creature; but its cradle was endowed with one single one-sided power: the power of holding on, first to the host, and afterwards to the cobweb; for upon the death of the spider the larva is inforced to remain on the spot, where the death occurred. And, indeed, for what should it go away? It has got enough to eat, and the only thing, it is longing for, is the still life during the metamorphosis. Contrary to what is the case with a number of other larvae, the longing of this larva does not manifest itself through meters' long walks but is ending at once in a cocoon being spun on the scene, where the longing come to existence, which, in the case of *P. eximia*, takes almost in every case place in the nest built by the host *Th. lunatum*, of the different kinds of choice matter which had dropped into the network.

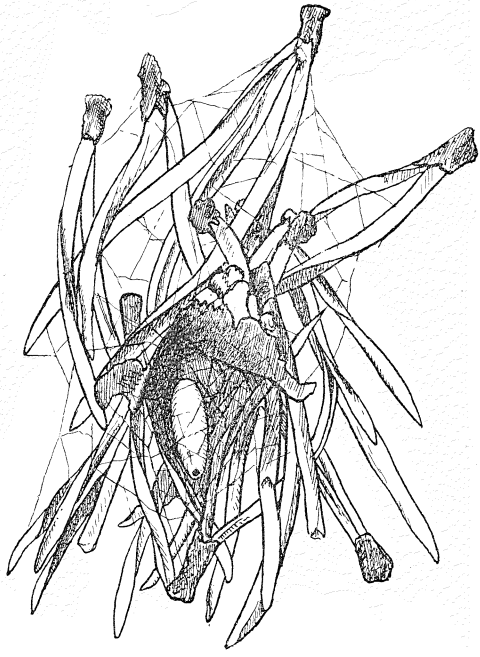


Fig. 4. Nest of *Theridium lunatum*, in the centre of which the egg cocoon of the spider, and below this the cocoon of *P. eximia*, showing the hole which the larva leaves open below.

The cocoon is always cylindric, fusiform, having however only the one end acute. The colour may vary, sometimes it is white, sometimes brownish like dead

leaves. In the bottom of cocoon the larva has left a circular hole, through which the excrement is expelled. As soon as the insect has been fully developed, it gnaws its way through the top of the cocoon, biting off a circular cover.

When after having spun its cocoon the larva is going to void its excrement, it is found placed quite in the bottom of the cocoon with the tip of abdomen pushed down quite to the opening. So, then is no mistaking of the purpose of this opening.

Having voided its excrement, the larva turns quite white, and the warts are marked along the back through the reddish chitin of the hooklets. Each of the warts now appears in the form of two red speckles, so that one would think, that there have been a pair of warts on each segment, while, in fact, the warts have been divided into two halves, each with its own hooklets.

On the 16th of May 1920 I found in the „Dyrehaven" a *Th. lunatum* with a dead, shrunk larva on the back. On the 18th of the same month, the spider moulted, and the shrunk larva fell down together with the skin cast off. After the moulting the spider became pubescent.

During the summer the insect has — at least — two generations. When, in the spring, the warmth has lured out the hibernating youngs of *Th. lunatum,* they are already found infested with larvae, in the month of July as well cocoons as larvae are found, but in the greater part of July it has been impossible to me to find any specimen of the said spider infested with parasites. Those specimens of *Th. lunatum,* which until now have escaped the attack of the fly, have now made their nests and oviposited, and having thus taken care of propagating their own family, a number of them are visited by the ichneumon flies, and towards the middle of August spiders with larvae on their back can often be met with;

for more than half the number examined may be infested with larvae. Thus we must believe, that the ichneumons developed in the latter part of summer will search out young Theridia for their progeny; to be sure it has not proved impossible to me to find a tolerable number of newly hatched youngs in that season, but none infested

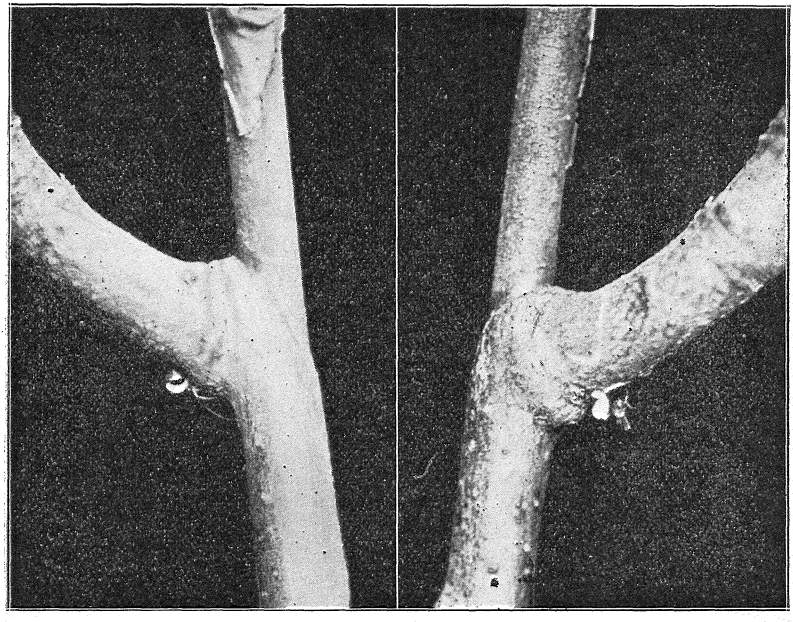


Fig. 5 A. Fig. 5 B.

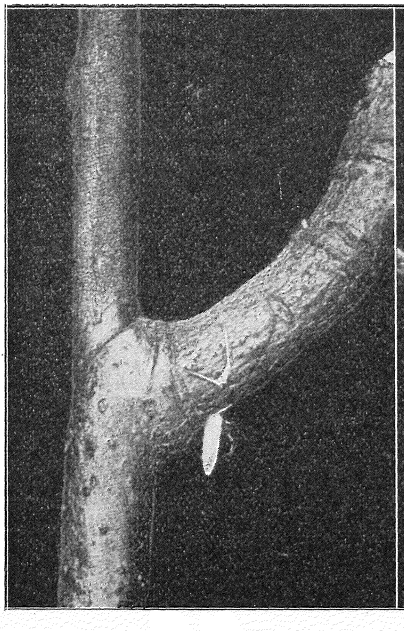
Fig. 5 A. *Theridium lunatum* on a Poplar branch with an *eximia*-Larva. Fig. 5 B. The parasite has left its host and fastens beside it.

with a parasite. However, in my opinion, there is no doubt but that the fact is as here supposed.

On August 6th 1921 at noon I witnessed in the „Tisvilde Hegn" a *P. eximia* ovipositing on its host, *Th. lunatum*. Unfortunately, I did not see the commencement, the paralysation of the spider; when I discovered the two antagonists the spider was sitting in her web motion-

less, the legs were drawn close to the body, only excepting the left fore-leg, which was stretched forward, a little aslant to the side. Placed behind the spider the Polysphincta was stroking her hindlegs, which seemed to be entangled in some threads of the web.

The fly passed from the threads of the web to the



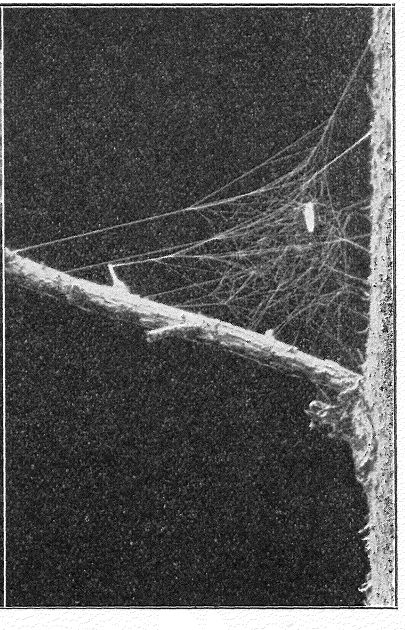


Fig. 5 C. Fig. 6.

Fig. 5 C. The parasite has spun cocoon; the remains of the host is seen next to the cocoon. Fig. 6. A web of *Th. lunatum*♂ (thus without nest in it) showing the cocoon of *eximia*.

abdomen of the spider, on which she sat touching it everywhere with her ovipositor, particularly between the front and the hind portion of the body. Having taken several positions and having been rather uneasy, she settled down with the head placed above the spinnerets, while her body was arching along the side of the spider so that the hind-end with the ovipositor was placed quite

between the femora of the hindlegs drawn up, slanting in over the front part of the abdomen. In that position the fly remained for several minutes, disengaged her hind-end, left the spider short after, went out on the threads of the web, by which she made her way to the

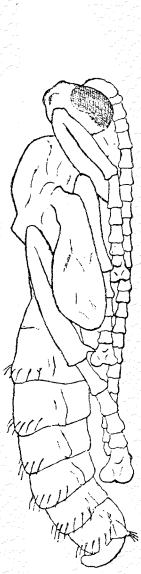


Fig. 7.

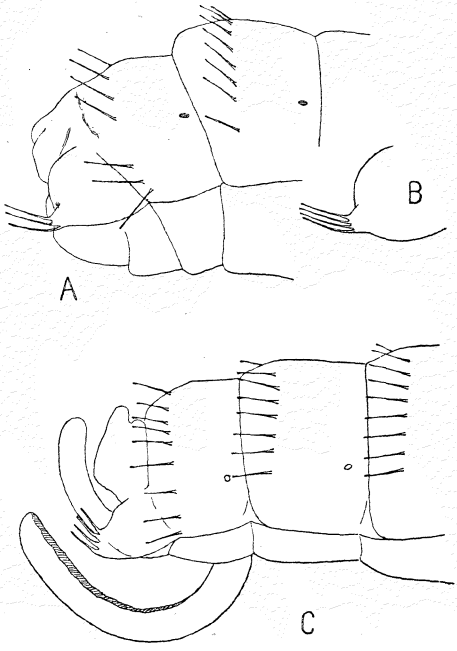


Fig. 8.

Fig. 7. Pupa of *Polysphincta eximia* ♀. Fig. 8. A Apex of abdomen of *eximia* ♂, the flap on 9th segment showing 3 bristles. B flap of another specimen showing 4 bristles. C Apex of abdomen of *eximia* ♀, the sheaths of the ovipositor somewhat subtracted.

edge and flew away. During the stay on the spider the fly had kept her wings up.

When I commenced my said observation, it was 12^{45} p. m. and the fly left at 12^{52}. Only at 1^{10} the spider began to move her legs, but only at 1^{26} she wholly recovered running about in the tube in which I had put her.

There can be no doubt but that, previous to the oviposition on the spider, the fly had paralysed the latter. The very fact, that the fly must be sitting on the spider itself and take time to orientate herself, says much for this supposition, as well as the perfect quietness during the oviposition and half an hour after.

2. **Polysphincta Nielseni** Roman.

This species was reared by me from *Cyrtophora conica* found in the wood Dyrehaven. It was firstly determined (by Prof. Schmiedeknecht) as *P. picticollis* Thoms. This latter species, however, was reared by Karsch from *Theridium lunatum;* and in Dyrehaven I found *Theridium lunatum* and in a certain locality *Cyrtophora conica* living in number side by side and each was always infested only with its peculiar *Polysphincta* viz. *Theridium lunatum* with *P. eximia* and *Cyrtophora conica* with the species here in question, this latter never occurring on the *Theridium.* It thus looked incredible to me that the *Cyrtophora conica*-parasite really was *picticollis,* and a reexamination of the species by Dr. Roman showed it to be a species new to science which is described by Roman in his paper in this volume p. 207 as *Nielseni.*

The larva of *Nielseni* is, contrary to the white one of *eximia,* yellowish, but is like this latter furnished with a dorsal row of 8 warts beset with hooklets. It also agrees with *eximia* in possessing 4 ventral taps and chitinous spots (here however paler) indicating the imaginal discs.

The advantages derived by the *Polysphincta*-larvae from their back warts are not fully understood until in nature you observe yourself how the larva af *P. Nielseni* having left the devoured host Epeirid, spins its cocoon in the centre of the web just where the spider used to sit. This method: fixing the cocoon in the centre of the host orb-web is described and figured by De Geer for

the species *P. aranearum* Retz., which according to Roman (p. 206) surely is identic with *picticollis* Th.; and now I have witnessed the same in the present species. The life story of *aranearum* related by De Geer is however very brief and he has not seen the special adaptions of the larva to its life in the orb-web; thus the following notes upon *Nielseni* are not superfluous.

If any of my readers should have the opportunity, in a specimen of the well-known vertical orb-webs of some Epeirid, to see a larva be safely suspended in the web and perhaps se it move a short distance therein, you will witness a most strange and most ingenious power in nature to think out precautionary measures for her creatures. Holding on with the back-warts, which catch and release their hold on the thin threads, the larva spins a cocoon for its protection during the pupal stage. From its very first beginning this network or cocoon is anchored to the orb-web and when finished, fitted to it, as if it had been always belonging there. The cocoon is spindle shaped, has a slight carina lengthways from end to end and is broadening a little to both sides, by which the attachment is rendered more safe. The cocoon is placed in almost perpendicular position along the middle-line of the orb-web, and in a natural way, fitted to the likewise perpendicular „path" of white patches of flocculent silk (stabiliamentum), often placed by the *C. conica* in her snare.

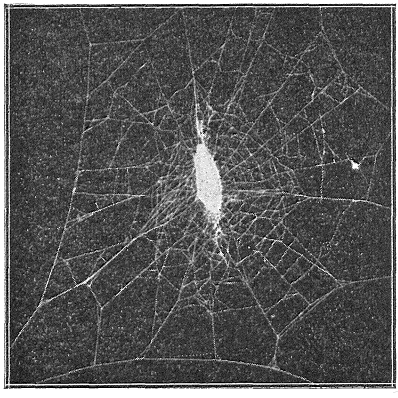


Fig. 9. Web of *Cyrtophora conica* with cocoon of *Polysphincta Nielseni* in its centre.

The last wheel spun by the spider previous to coming to her death by the bites of the larva growing more and more vigorous, will as a rule owing to its littleness bear testimony of the spider's weakness. Such a small web proves most useful to the larva as it should preferably

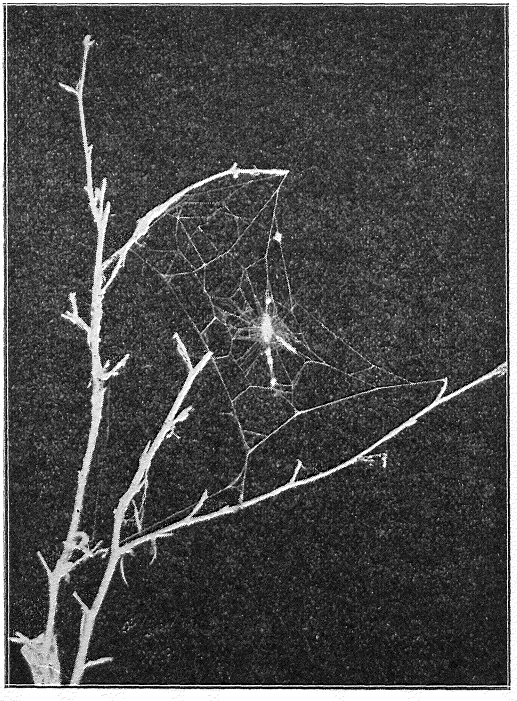
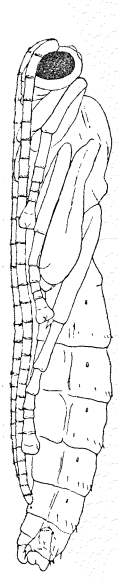


Fig. 10. Web of *Cyrtophora conica* showing cocoon of *P. Nielseni* and beneath this the stabiliamentum.

be kept distended during the time used in the pupal stage, and quite a small tissue is best preserved in undamaged condition. E. g. I can tell that under high winds a dry twig (fig. 10) together with web and cocoon was carried across the plain of the „Eremitage", brought to Copenhagen in a crowded tramcar without one single

thread bursting. It is however an exception to see quite an undamaged web. For days I have been walking in the „Dyrehaven" to find such orb-webs with cocoons. Only in some few cases I found the web undamaged, often it was so much spoiled that the cocoon was suspended from only three threads, sometimes from two only.



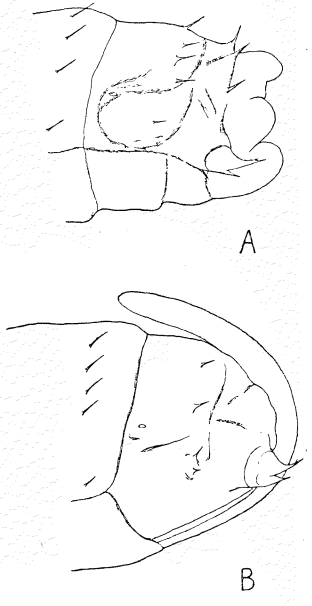


Fig. 11. Fig. 12.

Fig. 11. Pupa of *Polysphincta Nielseni*♂.
Fig. 12. A Apex of abdomen of *Nielseni*♂.
B Apex of abdomen of *Nielseni*♀.

In the spring the tender larvae are found on their hosts, most often arching over the petiole proper between cephalothorax and abdomen, concealed from the observer, when the spider is at rest; the host itself contributes to concealing the larva by means of its legs, the femora of which are kept in a slanting position drawn closely to its body, in case of this spider still more than in case of *Th. lunatum*. *P. Nielseni* as well as *P. eximia* has surely two generations a year; be it, however, remarked, that I have found larvae only from the spring to latter part of the month of June. On the other hand, I have found, in the autumn, on five occasions, small youngs of orb-weavers belonging to the Epeirids, all of which were infested with parasites. I have succeeded in wintering them, but at the arrival of the warmth they have died.

Notwithstanding, the rearing intended has not been without any result, as it is thereby shown, that these larvae of *Polysphincta* hibernate just in the larval stage.

To the above remarks it should, however, be added, that in the middle of July 1921, I found, at the „Tisvilde Hegn", a specimen of *C. conica* carrying a larva on her back. Though I did not succeed in rearing the larva, this single individual may perhaps serve to prove, that there are two generations, both of which are connected with the same species of spiders.

On May 27th 1921 I took at the „Horsekæret" (the Horse-Fen) in the Tisvilde Hegn a specimen of *C. conica* carrying a larva on its back. On May 22nd I took two specimens infested with larvae on the usual spot in the „Dyrehaven". On the night of the 27th to the 28th of May one of the said two spiders cast off her skin, while the larva kept its place on the back of the host. Evidently, after an ecdysis, the spider must necessarily feed, to which, however, the *C. conica* can not be forced when captured. In fact, a few days after, the specimen mentioned was sitting in the glass in faint condition; the larva did not grow, and as the host died, the larva too perished.

Polysphincta eximia is sitting on the spider when laying her egg on its back. Surely, *P. Nielseni* sits in a similar way in laying her egg on the back of *C. conica;* for, also in that case, the egg is placed close to the petiole, and the legs of this spider are pressed still closer to the body than those of *Th. lunatum,* and the parasite egg as well as the tender larva are also difficult to catch sight of, when the spider is alive and resting.

3. **Polysphincta pallipes** Holmgr.

In the spring 1918 I found in the „Dyrehaven" great quantities of cocoons, which after having been reared, proved to be specimens of the ichneumon-fly *Polysphincta pallipes* which formerly has not been reared.

At the same time some few *Polysphincta*-larvae were found on a small Theridiid spider, *Leptyphantes zebrinus* M. These larvae differed from the *Polysphincta*-larvae mentioned above in having warts only on 7 segments and on each of these segments there is not one (bituberculate) but two separate warts placed at the side of each other thus forming two parallel rows. The foremost and hindmost pairs of warts are however placed more closely together than the other ones. The last stage larva (having got its warts) is conspicuously hairy, the hairs being placed in rows round the segments, one row on each segment, the ends of more of the hairs, especially those on the sides of the body, are fine bifurcate, some moreover having 3—4 apices.

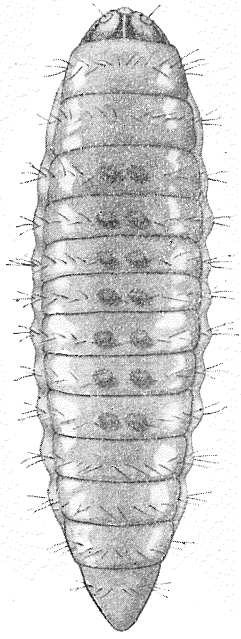


Fig. 13. Larva of *Polysphincta pallipes* showing the 7 pairs of dorsal warts.

The larvae developed into imagines belonging to the same species as that of the cocoons. The cocoons were all found in small cobwebs placed in the longitudinal grooves of the big beech-trees, in some cases up to twenty in one groove. Differing from the cocoons of *P. Nielseni* and *P. eximia*, they were quadrangular sharp-edged and tapering in both ends; in the bottom of the cocoon there was a hole, almost in every case filled up with the excrement of the larva. In some cases the colour was white, in other cases brownish like dead leaves.*)

I had started my excursion a little too late, a telling

*) As to the cause of the colour see later on pag. 184.

proof of which was the great number of cocoons, nor was it possible in the longitudinal grooves of the big trees to find more than three spiders (adult males) infested with parasites. In one case the larva was bristling from the spider's back; it was dead. The larva placed on the second specimen spun a cocoon like the great number I had found. Somehow or other the larva on the third spider must have been hurt; for one day it made its way half out of its old skin, which was left empty behind it. Having made this the larva remained quiet, only the movements of its mouth proved, that it was still alive.

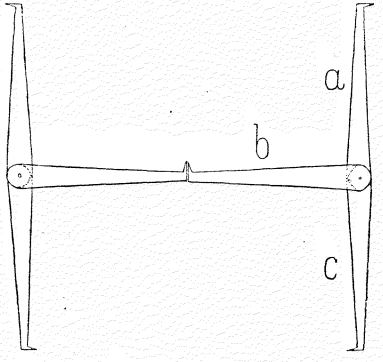


Fig. 14. Diagram showing the movements of the mandibels. a protruded, b in cross position, c lowered into the gullet.

The movements of the mouth answered the question, how the larva of a *Polysphincta* manages to perforate the skin of the host. Under the microscope all was obvious: Out from a small dark point in the middle of the „face", there came forward two brown points which at once disappeared into the head, and through the microscope I only observed the point, where they had disappeared. This was repeated over and over; so I had plenty of time to familiarize myself with the phenomenon and find out the peculiarities thereof.

The two brown points were of course the apices of the mandibles. The apex is hooklike and points outwards, when the mandibles are stretched forwards, (out from the mouth); when the mandibles are folded up transversally against each other they just will touch each other distally, and the two hooklike apices are then pointing forwards,

lying quite close along each other. This cross-position, however, was no position of rest, as the mandibles were seen disappearing into the head of the animal. As the skin was pellucid, they were most frequently visible a short distance in the head, before they quitely disappeared. They were like a door that can be opened outward and inward. When the mandibles were retracted, as to point in the longitudinal direction of the body, the hooklets again stood across the same, now, however, pointing against each other. Fig. 14 shows diagrammatically the said three positions of the mandibles. At large or small intervals the larva opened the mandibles, but in every case only for a moment, where upon they were again retracted.

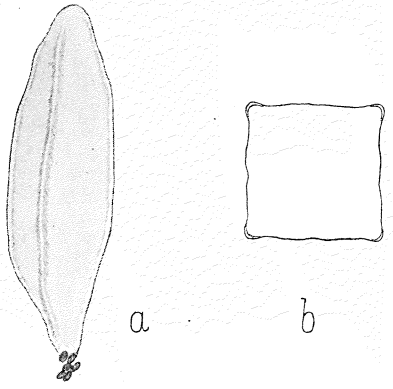


Fig. 15. a Cocoon of *Polysphincta pallipes*, with black excrement clumps below. b the same, in cross section.

It is a feature most commonly met with in carnivorous insects, that each mandible will separately work on the skin to be perforated, that thus a separate wound is inflicted by each of them, and that upon their working towards each other one large wound comes out. But this is not the case with the larva of *Polysphincta*, whose mandibles by means of the hooklets working jointly perforate only one little spot of the skin. By forwarding the mandibles the hooklets extend the hole produced as to enable the mouth to suck. In this peculiar function of the mandibles the mouth differs from what is usually the case, but thereby the larva need not damage the skin of the spider more than necessary; in fact, spiders are highly sensitive to injuries of the abdomen, and will

die, when they are stung with a needle. As the larva is interested in the spider remaining alive, until it (the larva) has performed its last moulting, the said arrangement of the mandibles must be considered to be highly adapted to its purpose.

Fig. 16. Bark of a beech, in the (invisible) cob-web in the groove of which are seen 4 cocoons of *Polysphincta pallipes*. Photo in nat. size.

Those Hymenopterous larvae, whose mothers paralyze the spiders, before the latter shall serve the young for food, are rapid in growth; in a little more than ten days they have gorged on food, and only the solid parts of the spider are left. Surely, it is necessary to these larvae

to be voracious, as in this way only they have the chance of getting food, that is not at last too much spoiled. By nature the *Polysphincta*-larvae are adjusted to a lower gearing with respect to eating away. They have a more delicate constitution, and carrion-food such as must be despatched by a Pompilid larva the last days of its eating-period, would not agree with a *Polysphincta*-larva. If this would so greedily peg away the spider, to which it is attached, this would die prematurely, and being in growth the larva cannot at that undeveloped stage utilize the dead animal, being unable to do that until the last 24 hours of the eating period, when, indeed, it regales itself at the top of its bent, leaving not a great many drops of juice in the skin of the spider.

For this ichneumon fly the year 1918 was a culminating year; in the spring 1919 I found but one cocoon, where in the preceding year I had seen cocoons by hundreds.

In the spring 1921 *P. pallipes* cocoons again were found in numbers in the Dyrehaven; as formerly, many of them were found in the grooves of the trunks, but the proper localities were the recesses and grottoes at the foot of the trees, formed by the overground parts of the roots. The locality was closely circumscribed: a 50 m. square; when starting from the said spot I only found a cocoon now and then.

On May 1st, 5th and 8th 1921 I made three excursions. The first day I found 46 cocoons and hosts with larvae; the second day 61 and the third day 14. The stage of development was not much varying. There were larvae in all cocoons clipped up, and no larva had voided excrement. The larvae still sitting on the host, with the exception of only 5 specimens, had got their warts and were having their last substantial meal; the five specimens mentioned got their warts 1 or 2 days after.

The reason, why I took the great number of cocoons and larvae and did not spare the „head", was, that I

wanted to get a pupa of a male. But only females were developed from the 121 specimens taken. It seems then that the male is very rarely found, and I suppose that the female propagates parthenogenetically.

Through this rich material I had an opportunity to test the stability of the marks, by which the species (as shown in a later chapter) can be determined from the

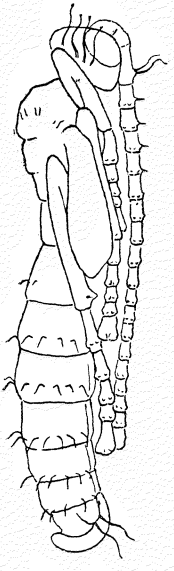


Fig. 17.

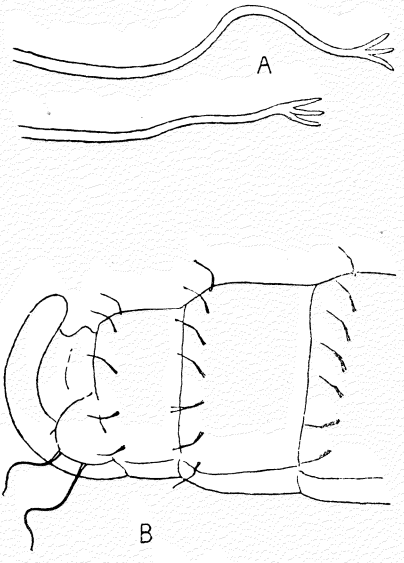


Fig. 18.

Fig. 17. Pupa of *Polysphincta pallipes* ♀. Fig. 18. A Trifid hairs from the head. B Apex of abdomen of *pallipes* ♀.

pupa: the mark of the last segment of the abdomen, the number of the hairs behind the eyes, the hairs of the foremost joints of the antennae etc.

Differing from the other Polysphinctae above mentioned *P. pallipes* does not make its way out of the cocoon by cutting off a circular cover, but gnaws an irregular hole, as if it were an ichneumon lying in a host cocoon, which was not of its own spinning.

At a trip to Farum on June 23rd 1920 I had the opportunity to observe, that the host — the specimen being a male — was not prevented by a parasitical larva on his back from mating with the female. On a hasel bush I found a male and a female to the genus *Erigone* mating on the underside of a leaf: Taking them up into a glass I found on the male a little white larva scarcely visible with the naked eye. Under the microscope it was almost pellucid. The host had white cakes of mould over the eyes and the head. The larva spun its well-known quadrangular cocoon; it proved to be a *P. pallipes*.

On May 17th 1921 a female pupa was taken in the „Tisvilde Hegn" in a web very similar to that of certain Theridia.

Another larva was taken by Mr. O. Bakkendorf in the enclosure of the „Fortunen" sitting on its host, the spider *Microneta viaria*. The result of the rearing was a female *pallipes*.

P. pallipes appears thus to be parasitic on several species of spiders, belonging to the sheetweavers.

4. **Polysphincta percontatoria** Müll. **var. gracilis** Holmgr.*)

As mentioned in the host list above, *Polysphincta percontatoria* has been reared from an undetermined Arachnid cocoon (Kryger) and from the case of *Fumea casta* „which more probably had been tenanted by a spider" (Morley), the host of the main form thus not being known. *Var. pulchrator* has been reared from *Theridium varians* by Karsch, and *var. gracilis* lives according to Bignell on *Epeira cucurbitina* and *Meta segmentata*, according to my rearings on *Theridium varians* and *Th. denticulatum*.

*) According to Dr. Roman *gracilis* is a variety of *percontatoria* and not of *pallipes*, as is the view of Schmiedeknecht.

The larva of *gracilis* is white. It seems to have only four warts provided with hooks on the back of 3rd—6th segments. I have however been unable to examine more than one larva under microscope and must confess that I am not quite sure that I have seen all warts present on the larva; the fact being that the *Polysphincta*-larvae are not always willing to show all their back warts, often keeping some of them, the foremost and hindmost ones, retracted in the body; and as the material of this species was very scanty I dared not preserve a larva in spirit but must rear it for identification of the species.

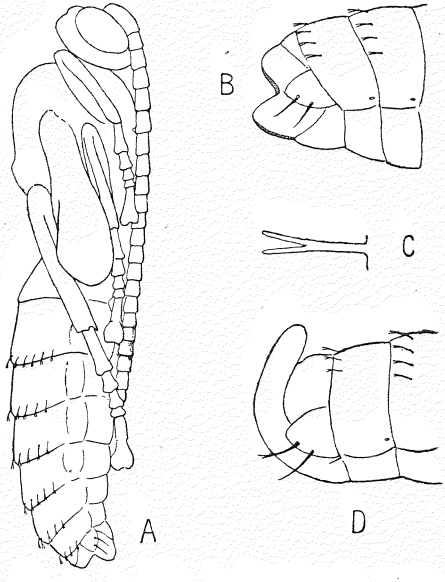


Fig. 19. A Pupa of *Polysphincta percontatoria* var. *gracilis* ♂. B Apex of abdomen of *gracilis* ♂. C Bifid hair from abdomen. D Apex of abdomen of *gracilis*♀.

The cocoon is loose-meshed, pellucid, white, of a cylindrical shape, rounded off towards the ends, the nethermost of which is open. Thus it looks quite different from that of *pallipes*, indicating that *gracilis* cannot be a variety of this latter; the difference between them must be of specifical value. Also a glance on the pupae will show so great differences between the two forms that they must mean two species; as mentioned under *pallipes* and furthermore treated in a chapter later on, very stable specific characters can be observed on the pupae, especially form and bristles of

the 8th abdominal segment and the presence or not of bristles on head and antennae etc. The figures 17—18 and 19 will show the difference.

First I found the larva on an errant *Theridium varians* in Tisvilde $^{20}/_{7}$ 1919. The imago reared proved to be a typical *gracilis*. Later on, in the month of July 1921 I found, in a stone wall near Frederiksværk, a specimen of *Theridium denticulatum* carrying a parasite on her back. The spider sat in her peculiar vase-like web, spun between the stones in the wall. The cocoon in its loose-meshed web became vertically suspended down into the vase from the ceiling of the same. The imago reared from this cocoon was some lighter coloured than that from *varians*.

5. **Polysphincta tuberosa** Grav.

This species has formerly been reared from *Epeira cucurbitina* (Bignell), *Epeira adianta* (Bertkau) and *Cheiracanthium carnifex* (Kryger). Bignell gives a description of the larva and cocoon, which does not agree with my statements set forth below; e. g. he mentions sucking discs on 2nd segment (1st body segment): 1 pair, and on 3d—4th segment: each 2 pairs; the two innermost pairs on 3d—4th segment were surmounted by rings of hooklets with 3—4 in the centre. On the back Bignell counted 8 tubercles.

Early in August 1920 I found in a ditch by the roadside between the ruins of „Asserbo“ and the „Sandkro“ three specimens of *Epeira quadrata* infested with parasites. Though there were enormous quantities of this orb-weaver, I found, in spite of searching energetically for three days, only the same three specimens, one on each day.

In view of delineating the larva and pupa, one of the larvae was killed after its last moulting, the second one after having metamorphosed into pupa; but the third

was allowed to accomplish its metamorphosis, and proved to be *P. tuberosa.*

I had brought no microscope along into the country, only a weak magnifier. So it proved impossible to compare in all details the three larvae and the two pupae in order to ascertain, that they were all of one species. As, however, all the hosts belonged to *Epeira quadrata* and found at the same limited locality, as all the larvae had the same colour and size and were placed alike on their hosts, and, finally, as the two spun cocoons were perfectly similar, there is no doubt but that the larvae and pupae pictured all belong to the *P. tuberosa.*

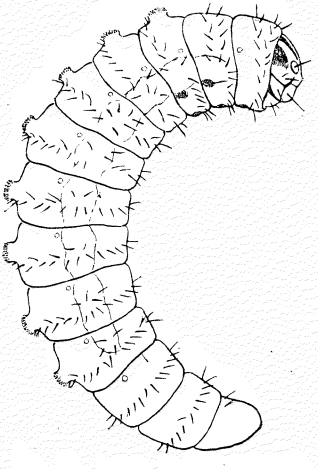


Fig. 20. Larva of *Polysphincta tuberosa,* seen from the side.

The fullgrown larva examined is greenish, highly hairy, and the 8 dorsal warts are densely set with hooklets without any blank space in the middle. As *Epeira quadrata* is bigger than the other infested spiders above mentioned, so this parasitic larvae is also bigger than any formerly mentioned.

On the ventral side of the full grown larva it was impossible to find the taps, which are so important e. g. to the larva of *P. eximia* for holding the larva fast to the „cake" of old skins, on which the larva rests upon its hosts. This larva too, I suppose, has had such taps, but I think, that the coming metamorphosis into pupa has considerably influenced the structure of the animal. On the 11th and 12th segment were seen a pair of spectacle-shaped spots on each, indicating the ovipositor discs, as well as leg and wing disc spots are found.

In the Whitsun holidays 1921 I took near Asserbo nine specimens of *Epeira quadrata* infested with larvae and could now solve the question if the ventral taps are present or not. In several of those larvae, three pairs of taps were found on the ventral side of the 7th, 8th and

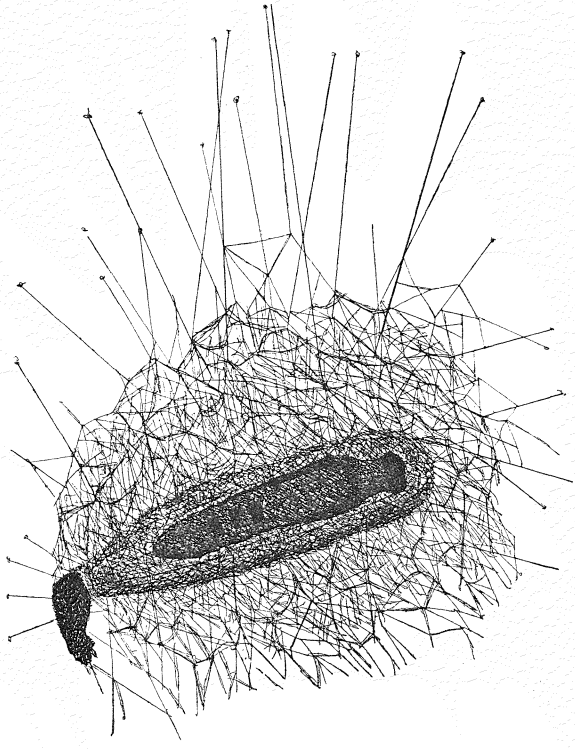


Fig. 21. Cocoon with pupa of *Polysphincta tuberosa*, on its loose-meshed sheet.

9th segments, after the larvae had left their hosts. The taps were directed to the rear and pressed close to the body, which falls well into line with the fact, that the „saddle" slides back from the larvae, when this disengages itself of it.

On May 21st in the morning one of the 9 *Epeirae*

quadratae infested with larvae had moulted: The skin of the abdomen and that of the cephalothorax as well as the skin of the legs was found rolled up, only the back-integument of cephalothorax remained loose on the back of the animal, fastened close by the waist. The larva kept its place on the spider.

When ready for pupation the *tuberosa*-larva spins a

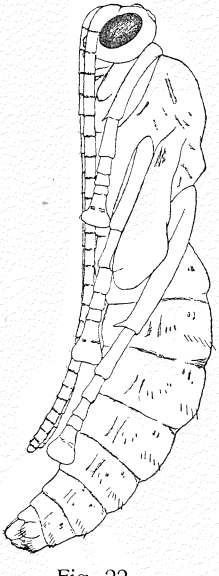


Fig. 22.

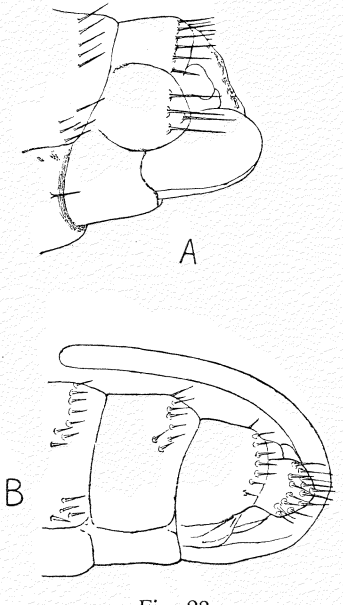


Fig. 23

Fig. 22. Pupa of *Polysphincta tuberosa* ♂. Fig. 23 A Apex of abdomen of *tuberosa* ♂. B Apex of abdomen of *tuberosa* ♀.

little sheet limiting the space where the pupation will take place, always in the retreat on this sheet the cocoon is placed. The cocoon is bigger than those of the other Polysphinctas; it is diaphanous because being loose-meshed; the colour varies from rather white to brownish; it is fusiform.

The pupa, especially that of the female, is easily known

having an exceptionally long ovipositor and more bristles on the abdominal flaps.

In the spring *Epeira redii* is found in numbers on the heath near Asserbo; often Polysphinctid-larvae are found on this spider and they proved, when reared, to be *P. tuberosa*. In this seasonal time *Epeira quadrata* is found much more seldom, and parasitized *quadrata* are only met with in the summer. Thus it is not incredible that *Epeira redii* is the winter host, *E. quadrata* the summer host of *tuberosa*, the different generations of this latter thus having their separate host species. At all events *E. redii* cannot act as host in the summer time, as it deposits her eggs and dies in the early summer and as the progeny is of small size in mid summer.

6. **Polysphincta clypeata** Holmgr.

At the beginning of the month of July 1920 I made, in the Tisvilde Hegn (i. e. the forest of Tisvilde), persevering attempts at finding parasites on the orb-weaver *Meta segmentata*. Every spider discovered was taken up and carefully observed through a magnifier. On day I succeeded in finding two specimens, each carrying a larva on the back of the abdomen, not however near the stalk but on the middle of back. The larvae were so tiny, that they were but dimly visible with the naked eye. As apparently there were but few spiders infested with larvae, and it was important to rear them, one of the spiders was put back in the web, where she made for a twig and there remained sitting near a gnarl. The next morning I saw hanging in the web a spider-skin cast off, and the *Meta* was sitting on the twig near the gnarl, attined in her new skin, but without the larva, which, consequently, had been slipped off together with the skin. Now the spider in reserve became a little more valuable. After a week it had not yet moulted, but it had not taken food either, the fact being, that it is prac-

tically impossible to get certain species of orb-weavers to feed in captivity. Recalling to my mind the old Danish saying: My kinsman is my worst enemy, another *Meta* was put into the glass after having been deprived of legs in order to render it inferior to the other spider. The method proved to be good: the spider infested with the larva got the better of its adversary, which was sucked out. Curiously enough, the victor died after a fortnight.

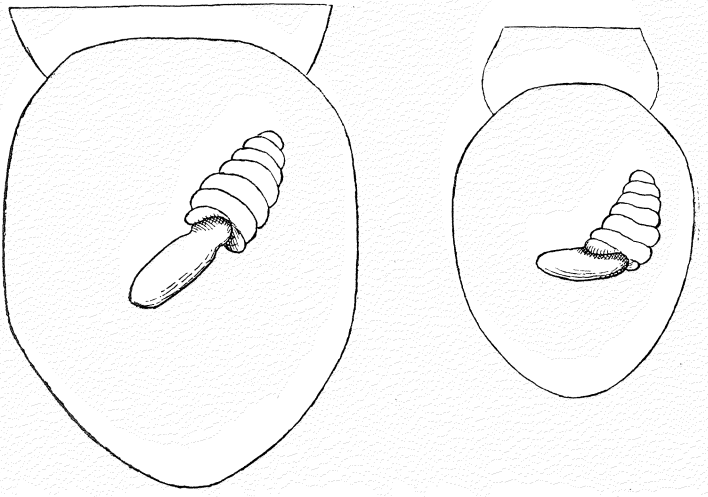


Fig. 24. Abdomen of 2 specimens of *Meta segmentata,* showing young larvae of *Polysphincta clypeata* in their covers.

New efforts to find more material were however successful: I found eight new specimens. All of the larvae parasiting on them were but small, even that specimen, which was last taken (on the 9th of August, just before the end of the holidays), which tells of a slow growth.

The larvae were fastened to the host in a peculiar way: The hindmost half of the body was hidden into a small cover, the eggshell, I suppose, which was glued to the skin of the host. The larva was slightly jammed by

the cover, so that the free part of it broadened somewhat to the side, being distinctly segmented. Six segments were seen outside the cover, the top of which was lengthened above, so that the last free segments was naked on the sides only, showing distinctly through its bulging along the rim of the cover, how much the larva was jammed. The part of the larva outside the cover was bent at an obtuse angle with the cover (and consequently also with the inside part of the larva); one could look below the larva close by the mouth of the cover*).

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*) On August 25th 1921, in the „Gribskov" Mr. Kryger took a specimen of *Meta segmentata* infested with a larva that was at such an advanced stage of development, that it approached the last moulting. The next day Mr. Kryger presented me with the specimen, which I kept in a glass for a few days, whereupon the spider died, killed, I suppose, by the larva, which however, took place previous to the larva having performed its last moulting. At the same time the larva loosened from the cake of skin, upon which it had been resting. This cake was situated on the abdomen of the spider and close to it was still lying the cover, by means of which the larva had been kept fastened to the host. If, in fact, the spider had died from the bite of the larva, then the larva must have been in too much of a hurry, and, to make matters worse, it had, at the same time, let go its hold of the „saddle"; for, in the numerous attempts of the larva at sucking out the dead host, it was not to be mistaken, that this was a difficult, if not impossible task; for with its abdomen loosened it could not effectually press its mouth against the body of the host. Consequently, the press of the mouth against the skin of the spider must arise from the arch formed by the body of the larva, and a close connection will only be caused by the larva arching its body. Then the fastened abdomen serves the animal as legs, which would have enabled it to press mouth and feed against each other. — At last all connection between larva and host ceased, and the former commenced moulting (the warts breaking out). The moulting, however, was not completed, as the larva died previously.

The larvae did not thrive, because the hosts got no food. Among the spiders, several began to peel on the cephalothorax and the abdomen; they were going to moult. The ecdysis, however, did not follow its normal course, only resulting in bursts of the old skin, which may possibly be ascribed to the unnatural stay in captivity, but also the larva may have contributed thereto. None of the spiders caught cast off the skin.

In the course of August and September all the spiders died but one, which was last caught and the most vigorous one. It had been taken on August 9th and had got nothing to eat until its death on Oktober 10th; only on September 26th a small piece of wadding well wetted was put into the glass, and the animal sucked the wadding so intensely, that its skin until then highly shrunken and wrinkled became distended and smooth. The spider itself somewhat recovered its vivacity. And so high became the pressure of the fluid, that everywhere water-drops were trickling out of the skin of the abdomen and legs. Now the larva began growing*).

About a week sooner it had drawn its tail-end out of the cover, by which, until then, it had been jammed and fastened to the host. Now, there was a cake of old skin close by the mouth of the cover, and a new thin cover had appeared round the hindmost part of the body, which, however, was not jammed; it was the remainder from an ecdysis, which has taken place just after the

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*) I have kept young parasitized Theridiae in a glass for quite a month without given them anything at all to eat. During such period whether the spiders nor the larvae did increase in size. The Polysphincta-larva thus bears comparison with a sucking young, who will get something to drink, if the mother is faring well, and hunger, if she has nothing to eat.

larva had detached itself from the cover. Now, this was empty, having, however, conserved its shape without breaking down. It consisted of two flakes, the inner of which did not fully reach the bottom of the outer one.

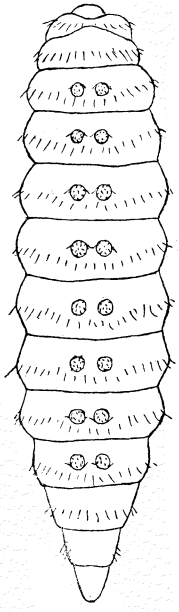

Fig. 25.

On October 10th at 4 p. m the larva having performed its last ecdysis killed the host. The warts did not appear so quickly as in the case of other species of larvae; only the next morning the warts were distinctly seen projecting from the back of the animal. Had the young larva been distinguished from the other species for carrying a cover, also the mature larva showed specifical peculiarities, viz. the warts, the number of which was sixteen, distributed in twos on 8 segments (3rd—10th segments). This double row of warts draws the attention to the unpaired warts of the larvae above mentioned (f. i. *eximia*), one side of which could be retracted separately, a property, which here had found expression in the fact, that every single wart is divided into two separate warts, independent of each other. On the ventral side also this larva possesses four taps, placed on the same segments as usual. Hairs are found on all segments of the body except the last; the hairs are found continuously around the body of the larva on the 2 anterior segments; on the 3d and 4th segments is seen a median

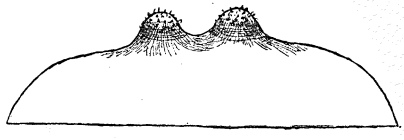

Fig. 26.

Fig. 25. Fullgrown larva of *Polysphincta clypeata*, showing the 8 pairs of dorsal warts. Fig. 26. Dorsal outline of a segment with its warts.

ventral area being quite bare. This hairless area is continued by similar bare areas on the following segments, but here the hairs are not continuing just as far below on the ventral side as on the 3d and 4th segments, the bare spots thus being longer than in these segments. In one case I found 11th segment hairy all round, but the hairs on the ventral side were small and shortly truncate.

As the larva had done feeding and begun spinning, I removed the threads already spun and the larva was laid on the back in a narrow cork-groove as to prevent it from falling over on its side. It now performed the same spinning movements as had done the other larvae, but the attempts at fixing the threads on the hindmost segment of the body were more energetic: the larva pressed its head deep into the weak skin, and, indeed, succeeded in fixing the thread on the segment itself; so the part played by the hair on the last segment of *eximia* — as set forth above — in spinning the cocoon, will certainly not apply here. It is the skin itself, that holds fast the webwork at the beginning, until it has taken so much form, that the threads are sufficiently supported through their mutual cohesion.

The cocoon spun by this specimen was white, dense and opaque with an opening on the lower apex and cylindrically tapering towards both ends.

As the *Polysphincta*-larvae had proved rapidly to develop into pupa and imago after their spinning cocoon and as I was very anxious to have the pupa of this species delineated for comparison with the formerly known pupae, the cocoon of this species was opened on October 18th, but the larva had not yet metamorphosed. In the night of the 18th to the 19th of Oktober the larva voided its excrement, but its horizontal position had not been good for that purpose, as the excrement formed a black liquid mass gluing undetachably to its ventral side.

In the same manner as the larva had been slowly developing towards the wart stage, it seemed to keep the same slowness also after that stage; for, on the 27th of December, I noted that it was still lying without having pupated. Though lying in a warm room, no change from day to day could be observed. Thus, this species seems to winter in the larval stage. The rather slow development tells of the existence of only one generation a year.

The spider-host had been living without any food from August 9th to Oktober 10th, having only on September 26th got some water. This means two full hunger months, which is the more remarkable, because during this long time the larva had sucked its blood. This case affords a splendid witness of certain spiders being able during a long time to keep alive without any food, nay without water, but it also shows, that the life of the hungry spider can be prolonged by means of plenty of water, and finally, what a small quantity of food the parasite takes from its host during the whole development towards the wart stage; it is necessary, that the spider does not die until that stage had been arrived at enabling the larva to hold on to the web.

On 4th of August 1921 I took in the „Tisvilde Hegn" a specimen of *Meta segmentata* carrying a parasite on its back. As in the cases above mentioned the parasite had its tail-end in cover. It was characterized by the host (the spider) having moulted without dropping the larva. The testimony of this ecdysis having taken place was seen on the back of the spider, the skin cast off having curled into a thin string above dilated but below fastened quite where the body of the larva was rising out of the cover.*)

*) also a *Meta* taken 5th of August 1922 moulted without dropping the parasite larva.

The phenomenon, that spiders infested with *Polysphincta*-larvae, are able to moult without dropping the larvae, is, thus, now established in such a number of cases, that it has become an actual fact: What should be considered impossible a priori, is nevertheless possible, which, however, does not mean that it is a usual thing; quite contrary, the reverse seems to be the usual case. Perhaps, the whole phenomenon is concerned with the

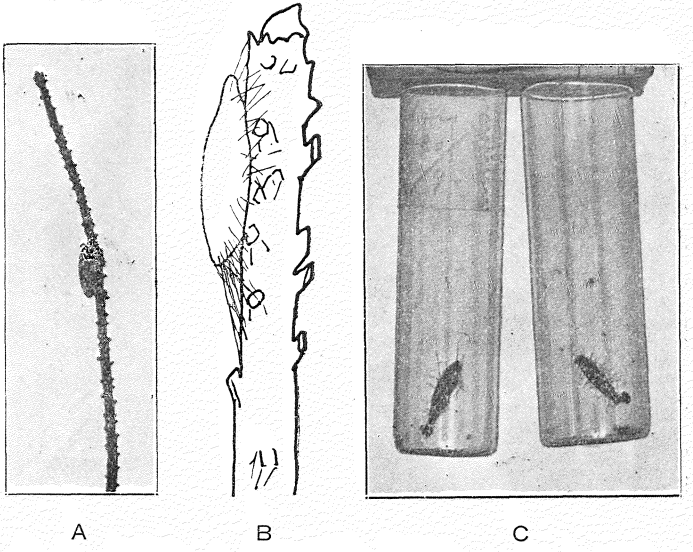

Fig 27. Cocoons of *Polysphincta clypeata*. A and C photos in nat. size.

paralysation performed by the ichneumon fly previous to laying her egg on the spider. It cannot possibly be random guess in nubibus, that in most cases the very paralysation checks the growth, thus rendering a moulting impossible. As to four species of spiders infested with larvae: *Th. lunatum*, *C. conica*, *E. quadrata* and *Meta segmentata* the existence of moulting has now been established.

In order to get more material of this slowly developing

parasite, and get it in a stage of development as advanced as possible when caught, I postponed to seek for them until the last week of my holidays (which ended 12th of August). I came back to Copenhagen having 4 infested spiders with me. In the last part of October they killed their hosts and surrounded themselves with cocoons, which were not open in the lower end. When freshly spun the cocoons were whitish, but short after the colour changed into dark brownish, which colour remained later on, surely on account of a salivary secernation of the larva.

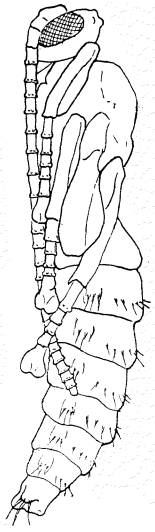

Fig. 28.

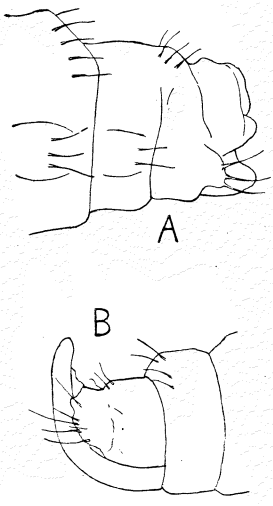

Fig. 29.

Fig. 28. Pupa of *Polysphincta clypeata* ♂.
Fig. 29. A Apex of abdomen of *clypeata* ♂.
B Apex of abdomen of *clypeata* ♀.

Also the larva of *pallipes* spins a whitish cocoon which shortly after the spinning becomes dark coloured; not all — though most of them — however will change colour, as formerly recorded as well whitish as brownish *pallipes*-cocoons are found in the open air.

For constating if the colour changing was due to a larval secrete or perhaps simply an influence (oxydation) from the air, I watched a number of *pallipes*-larvae spinning cocoons and removed the larvae from the cocoons as soon as these were finished. The cocoons then always remained whitish or pale as the colour was when

freshly spun, and I thus think it proved that the brown-colouring of the cocoons is due to the larvae; when a number of cocoons will remain white I think it most credible that the cause is too bad state of nutrition, the host having hungered or perhaps being too little to the parasite; the rearing recorded p. 181 – 182 favours the belief that this is the case.

Also the cocoons of the other Polysphinctids surely normally will begin whitish and later on change into brownish, though I have not directly made the observation, but I have at every case seen a cocoon of *eximia* whose nethermost apex was whitish, this colour quite contrasting to the dark colour of the rest of the cocoon; the larva surely had „forgotten" to colour the apex.

The dark coloured cocoon of the present species is very interesting, as it shall hide the untransformed larva during the winter. It quite resembles the withered spruce twig, on which it is placed and is thus scarcely discernible from this. That one figured on fig. 27 B was found in Tisvilde Hegn in the middle of October 1921. That the cocoon had no opening at the lower apex is surely also on account of the wintering, and for the same sake its walls are thicker than usual. Fig. 29 C shows 2 cocoons spun in captivity; the excrements are voided, blackish and fluid.

The Polysphinctas caught by me in the autumn were wintered in a rather cold place, but were moved to my study in last part of February. I then saw that the parasite of *Meta* had wintered in the larval stage. It did not succeed to me to get more than 2 transformed, a male and a female, but then this form could at last get its specific name, as the 2 specimens were identified (by Dr. Roman) as *clypeata* Holmgr., a species whose host was not known till now. The male became an imago the 19th of March, the same day as the female transformed to pupa, the female became an imago $^4/_4$ 1922. The newly

transformed male imago showed a reddish blunt cone emerging from the anus, it however soon voided excrements, a long vermiform whitish mass, and then the cone again disappeared.

7. **Polysphincta discolor** Holmgr. **var. obscura** Roman.

On July 13' 1922 I found in Tisvilde a nest-like web of a spider on a heath, and within this web was suspended a cocoon through the meshes of which a pupa could be seen. The host web most likely originated from a Theridiid, as its threads were very fine, but a closer determination is impossible. That the parasite's cocoon must originate from a *Polysphincta* which I had not seen before, was quite sure; the imago which was reared on July 15' proved to be *discolor obscura n. var.*, according to the denomination af Dr. Roman (see p. 209). *P. discolor* has formerly been reared by Habermehl, but he too did not know the host.

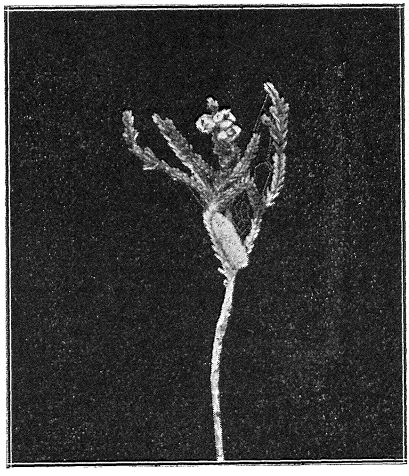

Fig. 30. Nestlike web of a Theridiid on a heath, with the cocoon of *Polysphincta discolor* var. *obscura*.

The cocoon of my specimen was very narrow and the pupa lay very turbulent, therefore I did not try to release the latter for delineating, as a splitting cut surely would have hurt it, such as is often the case when opening cocoons.

8. **Zaglyptus varipes** Grav.

J. P. Kryger mentions (l. c. p. 262) that he has reared *P. varipes* from *Cheiracanthium carnifex*, and that from the host itself as well as from the egg-cocoon of the same. A priori it appeared to me incredible that nature should have endowed an ichneumonid species with freedom of choice, whether it preferred to lay its eggs on the back of a living spider or among the eggs of the same spider and at the same time in the former instant only laying 1 egg, in the latter a half score of eggs. A reexamination of the material of Kryger, now in Zoological Museum Copenhagen, showed, as said before, that the spider-parasitizer belonged to *P. tuberosa*, while the egg-parasites were correctly determined as *P. varipes* Grav., this latter species thus living as parasite in egg cocoons of *Cheiracanthium carnifex*.

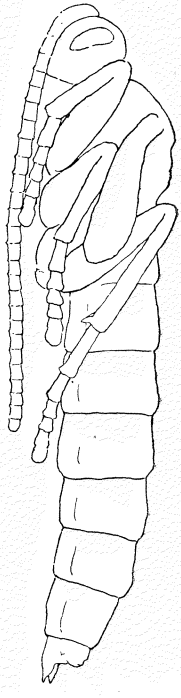

Fig. 31. Pupa of *Polysphincta varipes* ♂.

Among the material of Kryger there were both larvae and pupae of *P. varipes*, the larvae having completed their last moulting. Like the species previously mentioned, which must pupate in snares, the larvae have warts and hooklets. In the alcohol, where the were kept, the cuticula had got loose from the underlying tissue; so they were standing detached behind the clear chitinous membrane, while the hooklets were placed on the latter, thereby showing themselves to be cuticular formations.

One would think, that in the case of an egg-parasite warts and hooklets should be unnecessary, and thus quite disappear. — But this endowment by Nature is in no way superfluous, as such a larva when pupating is thereby

allowed to move from place to place in the cocoon and in the last hour of the feeding period to search for eggs which would otherwise be out of its reach. The presence of these hooklets must however be considered as a systematic character i. e. present in and common to all the different species of Polysphinctids s. l. thus also appearing in species living otherwise than ectoparasitic on spiders themselves. In this latter case the presence of the hooklets consistent with their use is easily understood; also here in *varipes* we can see that hooklets can be used, when present; but other parasites living as *varipes* in spiders' egg cocoons do not possess any hooklets, thus showing that a problem can be solved in different manner according to the different aptitudes.

On June 23th 1920 I namely found at the „Ganløse Ore" (the forest of the village of Ganløse) an egg cocoon of *Epeira cucurbitina,* in which 10 larvae of the ichneumonid *Pezomachus fasciatus* F. The larvae being in the last stage before pupating, had on their backs eight weak bulges, viz. on the 3rd—10th segments, but without hooklets. The larvae made their way through the meshes of the egg cocoon by stretching the body-segments and thereafter pushing the wart-like bulges up between the threads of the cocoon in support of the progressive movement.*)

In another egg cocoon of *E. cucurbitina,* — be it said — I found the larva of a parasitic fly, which was moving round between the threads of the cocoon by hooking on the threads by means of the mouth-hook-

*) Only five of the 10 larvae reached the stage of imago, two were wingless females, three winged males. On *Pezomachus* Kryger writes: „It may be remarked here, that it was quite useless to put individuals together from the same generation, as brothers and sisters do not pair with each other". The individuals, which were reared by me, paired willingly with each other in the glass, where they were kept.

lets and then by drawing after the body, a very fine analogon to the mode of motion of the Polysphinctid larvae in the cocoon.

9. **Tromatobia oculatoria F.**

If in the spring time or the early summer an egg bag of the orb weaver *Zilla atrica* is opened and examined you will rather often observe, that it does not contain the eggs of the spider but one or two (seldom more) Hymenopterous larvae. These larvae have hibernated as full grown larvae having ceased to eat, but any trace of a cocoon is not yet spun. Imago is very easily reared (in the month of May) and proves to be *Tromatobia oculatoria.*

The host *Zilla atrica* uses a year in completing its life cycle, thus only one generation appears a year; the oviposition takes place in the autumn, and the young ones will hatch in May, a little earlier or later according to the temperature of the spring. When the *Tromatobia* emerges, thus no fresh egg bags of *Zilla* are present for oviposition for half a year. Thus it is surely necessary for the ichneumon to have another host too for its eventual summer brood. Investigations made in Tisvilde Hegn in July—August 1921 showed that the *Tromatobia* really has two generations a year, the orb weaver *Cyrtophora conica* acting as the main host for the summer brood, *Zilla atrica* for the winter brood. More rarely egg bags of *Epeira cucurbitina* are found infested by the summer brood and *Epeira diadema* by the winter brood of the wasp. Using these commonly occurring spiders as hosts *Tromatobia oculatoria* will be able to accomplish its whole life cycle during the year*).

*) The number of individuals reared from a single egg bag as well as the proportional number of males and females will appear from the following dates:

Verte.

As shown above only *Epeira diadematа* was earlier recorded as a host for this parasite (Laboulbène, Morley). When Morley describes a larva found in the egg bag of *E. diadematа* but not reared, as the larva of *T. oculatoria,* this cannot be correct; it does not at all agree with the real larva which I have had in numbers, and as far as can be judged from the brief description and rough outline in Morley (l. c. p. 114—115) it is not at all a Hymenopterous larva, but certainly a Dipterous larva *(Acrocera?)* if anything.

The real larva of *oculatoria* lives freely in the host egg bag between the eggs which it devours, only leaving the empty egg shales. Having completed its larval moults and ceased to eat — this latter commonly being identic with having devoured all egg contents in the bag — it begins spinning a cocoon within the bag. If it has lived solitarily in the bag, it simply uses this latter, lining it however with some cocoonous texture and thus making use of the whole space; if two or more larvæ are present, the egg bag will be so much distended by the loose cocoons inside it that its fine spherical form changes into a more irregular one, doing it easy for the collector to find egg bags parasitized. The egg bag of *Epeira diadematа* is however so big, that the cocoons inside it do

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Egg bag of *Zilla atrica* (Dyrehaven, Tisvilde Hegn):

1 larva was found in 11 cases (6 ♂♂, 5 ♀♀),
2 larvæ were „ „ 7 „ (3 ♂♀, 2 ♀♀, 2 ♂♂),
3 „ „ „ „ 2 „ (♂♂♂, ♂♂♀),
4 „ „ „ „ 1 „ (♀♀♀♀).

Egg bag of *Cyrtophora conica* (Tisvilde Hegn):

1 larva in 50 cases
2 larvæ „ 17 „
3 „ „ 5 „
} altogether 27 ♂♂, 38 ♀♀.

Egg bag of *Epeira cucurbitina* (Tisvilde Hegn):

1 larva in 1 case (♀),
2 larvæ „ 1 „ (♂♀),
4 „ „ 1 „ (♂♂♂♂).

Egg bag of *Epeira diadematа* (Dyrehaven):

2 larvæ in 1 case (♀♀).

not influence and alter its shape. When the parasite larva begins spinning cocoon the empty egg shales of the host will generally be pushed into the web threads of the bag or even through them so that they will drop off. The excrements are voided immediately before pupation and are found in the cocoon — when in *Zilla atrica* bags (according to my rearings in March 1922). But when in *Cyrtophora conica* bags in the summer time the larva often will protrude its apex of abdomen between the threads of the bag and then leave the excrements as drops which will dry up and later appear as clear, coloured spots (commonly 2—4) on different places on the outer side of the bag — and leaved at different time.

The egg bag of *C. conica* is rather loose-meshed (as not intended for wintering), it is light and diaphanous as well as often somewhat distended by the parasite larva; thus this web is the most convenient for observing the larva during the cocoons-pinning. As mentioned above the cocoon when ready will appear much more spacious than the place formerly occupied by the larva; the larva has the shape of an arc and is thus pressed against its feed inside the arched cocoon; as a pupa it lies extended in a straight line and needs a larger (in every case a longer) space around itself.

When during the spinning of the cocoon the egg bag is held against the light we witnes that the larva during long time is working situated beneath the ceiling of the pupal chamber, the back upwards, just as a toy balloon or another body able to hang in the air and without any connection with the bottom of the chamber. That no such connection is present is easily substantiated when we cut the lower half of the chamber away and observe the larva, which is still hanging above without dropping down. When touching the back of a larva taken out from the cocoon we next substantiate that no sticking matter causes the strange situation. On the contrary a

manifying glass will show that a dark coloured oval is present on the back of 3th—10th body segment, thus in all 8 such ovals being present. The ovals are rather narrow and their greatest extension is in the breadth of the body. Under higher magnifying powers each oval will prove to consist of small spines which are directed obliquely downwards and outwards, as the oval is placed on a rather distinct protruded tubercle. The oval is not completely closed laterally, more correctly spoken the spines are arranged in two fields on each segment, an

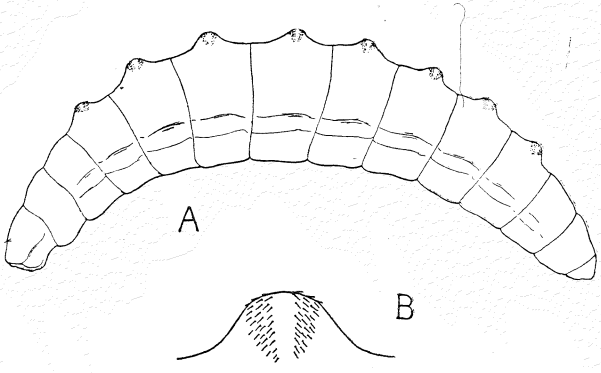

Fig. 32. A Larva of *Tromatobia oculatoria.* B a dorsal spine-bearing wart, greatly enlarged.

anterior and a posterior one, each of them being broadest in the middle, and separated by a naked middle part which laterally continues in the likewise naked general surface of the body. This naked central part can be retracted into the body so that a transversal furrow appears instead of the protuberance. At this retraction the two spine-bearing fields will approach each another and the spines will be directed quite upwards.

By means of this endowment with spines and the faculty to retract the naked part centrally to these the larva is able to seize and release the threads of the egg bag at pleasure and thus to walk within the bag. Con-

trary to the use which *Polysphincta* makes of its hooks the retracting will serve the releasing of the threads. As *oculatoria* does not possess hooks but only spines, and

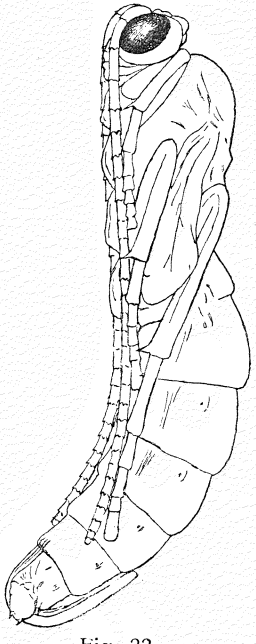

Fig. 33.

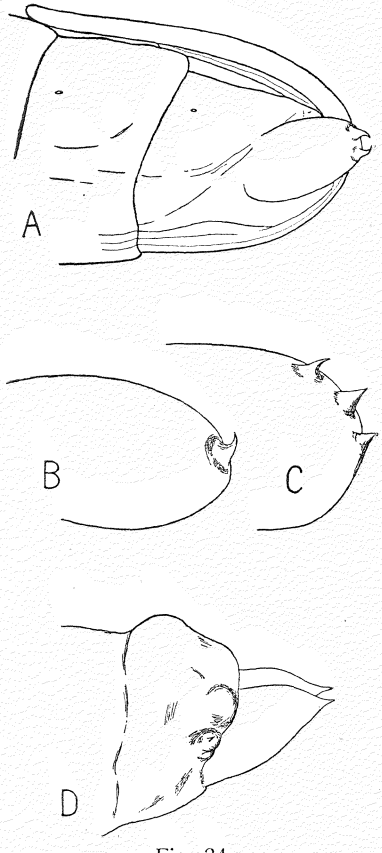

Fig. 34.

Fig. 33. Pupa of *Tromatobia oculatoria* ♀. Fig. 34. A apex of abdomen of *Tr. oculatoria* ♀, the abdominal flaps showing 2 spines, B and C flaps of other specimens showing 1 or 3 spines, D apex of abdomen of ♂ showing 2 spines.

as it is not able to retract the latter themselves in the body, it cannot hold so firmly by the web as the *Polysphincta* larvae. But just so firmly a holding on is not

necessary for *oculatoria;* it is born in a silken chamber which is not left by it before the imago escapes; on the contrary the *Polysphincta* larva when ready for pupation is not hidden behind any protecting web, it must to a much higher degree be able to keep a firm hold as it otherwise would finish on the ground for a victim to ants and other robber insects.

As well as *Polysphincta* also *oculatoria* in the younger stages does not possess the armature of spines; only when it reaches the ultimate larval stage the spines will appear.

It is interesting to observe the attempt to establish a simility in the equipment of *Polysphincta* and of *oculatoria*; Nature endowes its creatures with the equipment which they need and not more. Therefore the larvae of *Polysphincta* got their warts and hooks as well as an eminent power in using them; the larva of *oculatoria* must be content with a more simple armature, this however being quite sufficient for it, and is not equipment with the quite sufficent the real perfection?

When imago emerges from the pupal chamber, it deposits its excrements as a long vermiform, whitish mass.

10. **Tromatobia ovivora** Boh. (angens Grav.)

Tromatobia oculatoria is the parasite most commonly met with in the egg bags of *Zilla atrica* and *Cyrtophora conica.* In few instances I have reared the closely allied *T. ovivora,* in 5 instances from egg bags of *Cyrtophora conica* (Tisvilde), all containing 1 larva (3♂♂, 2♀♀).*) and in 2 instances from the bag of *Epeira diademata* (Tisvilde), 2♂♂. I am sorry that I was not able to recognize or delineate the pupa of this form, as this perhaps would solve the question, if *ovivora* is a separate species or only a variety of *oculatoria* as Hellins proposes.

*) I also reared *ovivora* from an unknown spider's eggbag. This took place some years ago, when I was not able yet to identify the egg bags of the hosts.

Five specimens (3♀♀, 2♂♂) reared from two *Cyrtophora conica* bags (Tisvilde) were determined by Roman as „transitorial form to oculatoria".

As hosts were formerly noted: *Epeira* (Taschenberg), *Lathrodectes tredecimguttatus* (Telesphore) and undetermined spiders (Boheman, Brischke, Ratzeburg, Taschenberg, Giraud). Ratzeburg also mentions the plant wasps *Nematus septentrionalis* and *Lophyrus ? frutetorum* as well as a moth *(Geometra alniaria* or *G. tiliaria)* as hosts, but this must be erroneous.

Once I reared a hyperparasite from the bag of *C. conica* — together with *T. ovivora* — the only instance where I reared two different forms from one host specimen. It proved to be *Hemiteles ? areator* Gr.

11. **The pupae.**

With exception of *discolor* var. *obscura* pupae of all the species of *Polysphincta* mentioned in the foregoing chapters *(eximia, Nielseni, pallipes, percontatoria var. gracilis, tuberosa, clypeata*) have been available for closer examination and delineation. The examination proved that not only the imagines and the larvae are specifically distinguishable, but also the pupae will show so characteristical differences that it must be stated that also the pupal stage has value as to systematics, f. i. the pupae of *pallipes* and *percontatoria gracilis* are more distinctly different than the imagines.

The most important specific characters, easy to be established and perfectly reliable, are found at apex of abdomen. Firstly the genital armature has a varying length in the different species, thus in the female sex *tuberosa* is easily recognized having a long ovipositor, the distal part of which is curved forwards lying parallel with the dorsal side of abdomen and covering more segments, in *Nielsseni* the ovipositor is much shorter, only covering 9th segment, and in the other species (*eximia, pallipes,*

gracilis, clypeata))* it is so short that it does not cover any segment from above. In contradistinction to *Zaglyptus*, where the male genital armature is long, this latter is not very prominent in *Polysphincta* (mostly however in *tuberosa*).

The most important specific feature is however two flaps or flat protuberances (one on each side) which are found posteriorly on 9th abdominal segment, and which in the female will serve as a lateral support of the ovipositor. These flaps are varying in size, and also the bristles or dentioles with which they are set, are differently developed in the different species. Thus in *eximia* the flaps are rather large, broader in the female than in the male, and posteriorly ending in 3—4 (most often 4) upwards bent long, stiff and blunt bristlelike teeth. In *Nielseni* the flaps are much smaller than in eximia, deeply bifurcated; the uppermost branch ends acute but shows a minute spine above near apex, the lowermost branch is shorter and smaller, ending simply acute. In *pallipes* the flaps are above semicircular in outline, set with 2 long S-shaped bristles. In *gracilis* the flaps end more acute than in *pallipes* and like in this they are set with 2 strong bristles which here however are shorter and simple (not S-shaped). In *tuberosa* the large flaps are set with a number of bristles (varying from 4 to more than a dozen, the most in the female) which are not much longer or stronger than those on the preceding segments. In *clypeata* the flaps are small, in the female rather or quite rudimentary, set with few (3 or a few more) slender bristles.

Characters of systematic value are also found in the bristle armature of the abdominal segments: a transversal row of bristles is found on each segment, at every case on the dorsal sclerite. In *tuberosa* the lowermost bristles are arranged in a more irregular group. Among the other species, where only a regular row is found on each seg-

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*) varipes is not known in the female sex.

ment, *Nielseni* has rather few short and acute bristles, *eximia* more longer and blunt ones, in *pallipes* they are suddenly bent and a few of them are deeply bifid, the row continues downwards to the edge of the dorsal sclerite; finalli in *gracilis* all the bristles are bipartite. *Pallipes* is moreover characterized having a row of 4—5 long S-curved bristles behind the eyes, their very apices tripartite; two long S-curved bristles are also found on the antenna in its basal part, and short bristles or hairs on the joints immediately following.

Also the antennae are varying in length, in conformity with their relative length in the imago, longest in *Nielseni.* The length of the body is generally 6—8 mm, the pupae belonging to the biggest imago type of course being the biggest.

In *Zaglyptus* (*varipes*) the male genital armature is long, reaching far beyond the dorsal part of the segment, and the flaps on 9th abdominal segment are very small, appearing as a little, almost not discernible tubercle, ending in a just as rudimentary spine. In contradistinction to *Polyphincta* the abdominal segments are quite nude.

In *Tromatobia (oculatoria*) just as in *Zaglyptus* the male genital armature is long, reaching far backwards, and the abdominal segments are quite nude, these features indicating, that it is quite right to remove *Zaglyptus* from *Polysphinctini* and to unite it with *Tromatobia* in *Epiurini.*

In the female sex *Tromatobia oculatoria* possesses large flaps on 9th segment, these flaps normally ending in 2 broad teeth the apices of which are curved towards one another. The number of teeth is however not quite constant, the number being in 1 instance 3 on one side and 2 on the other and in another case 1 on one side and 2 on the other. In the male the flaps (just as in *Zaglyptus*) are reduced to small tubercles, often scarcely discernible, here beset with 2 small, but straight spines, the number of which however as in the female being inconstant,

sometimes only 1 being present on one side or quite missing.

A similar instability in the number of spines on the specific character is also met with in other forms; as mentioned above it is seen in *Polysphincta eximia*, and I can add that I also stated it in the Pimpline-like Ophionine *Orthopelma luteolator* Gr. which is commonly reared from the galls of *Rhodites rosae* and which also I have reared in numbers. The flaps are here in the female elongated and bandlike and tapers in most cases in 1 spine, but sometimes it in one or both sides will be bifid (in one instance 3 spines are counted in one side) — this increasing often taking place in the female, while the male on the contrary often shows weak or no spines and rarely 2 spines in on side on a flap which is greatly shortened and often scarcely discernible.

12. My results compared with those of Bignell.

Finally, I cite the biological part of Bignell: The Ichneumonidae (Parasitic flies) of the South of Devonshire. The benevolance of Mr. C. J. Gahan, British Museum, has enabled me hereto, as at my request Mr. Gahan kindly has procured a copy of the said part of the paper of Mr. Bignell, which I could not get hold of otherwise, and for which I thank him very much.

„Other species, those of the genus Polysphincta, do not attack the egg-bags, but have the audacity to make the body of a large spider the feeding-ground for their offspring, and I believe do not object to any species that is large enough to sustain the larva. I may be in error, from the fact that it is a rare occurrence for a naturalist to have the opportunity of obtaining such examples. I have been able to identify only two species thus attacked, but was fortunate to breed the parasitic flies.

I believe I am the only person who has ever seen the fly attack a spider in its native haunts. It may be

interesting to know how the ichneumon obtains its end. Having selected a spider in which it has some confidence, she approaches it carefully, but the spider, objecting to the confidence trick, drops from its hiding place on the brough of the tree by the usual silken cord. The ichneumon fly does not appear to be the least troubled on that account; taking advantage of the spider's rope she very leisurely walks down to the spider, and apparently coaxingly touches it with her antennae. But the spider objects to the patronage and makes a further drop: in a few seconds the fly follows the object of her adoration and again touches the spider, and she, knowing her foe, resigns herself to her fate*) and does not move. The fly turns round, walks backward until within striking distance, and then thrusts her ovipositor into the thorax and deposits her egg. The ichneumon egg is hatched in about forty-six hours, the larva taking about ten days in consuming by suction the unfortunate spider. When feeding, it lies sack-like across the spider's back until it is almost consumed; when the larva finds the foundation on which it has been resting getting inconveniently small, it attaches itself to the web the spider made, by the tubercles with which it is provided on its back, for the purpose of feeding on the last remains of its victim and making its cocoon. When the attachment is accomplished the legs and empty skin drop to the ground.

The larva, suspended by the back, has now to make itself a cocoon in which to pass the pupa stage. The larva takes about three days to do this work. It is during this time that the eight tubercles on the back of the larva have to play such prominent parts, having to perform the work of the claspers of an ordinary caterpillar. When a tentacle, attached to the silken cord, has to be removed,

*) Many animals knowing their foe, after being chased a short distance, suddenly stop and resign themselves: the rabbit has been often heard crying, and seen to await the arrival of the stoat or weasel after a very short run.

it is done by withdrawing the hooklets into the tentacle, when it at once becomes disengaged and ready to make another attachment. The anal segment has important duties to perform, while the cocoon is making, by carrying the silken thread from the head into the corners, where the blunt head of the caterpillar could not carry it, or adjust it to its satisfaction. I first observed the anal segment used while the caterpillar was feeding, by bringing it to its mouth for the purpose of removing some muscular fibre that had got entangled about its mandible. When full-fed, the larva is about three—eighths of an inch in length. The fly is mature and escapes from the cocoon in about twenty days.

This species, *Acrodactyla degener* Haliday, has been bred from a spider, *Linyphia obscura*".

In comparing the observations made by Bignell with those made by me, it will be seen, that we have not the same view of what we have seen. Bignell, however, has had no rich material in support of his suppositions, which I have had in support of mine. But it will surely be admitted, that I am somewhat justified in comparing critically the observations of Bignell with my own, which I shall now try to do.

My researches seem to show, that Bignell is wrong in stating, that the Polysphincta does not object to any species of spiders, so long it is large enough to become the feeding-ground of her larva; he speaks indeed with some reservation on this point. Surely, most of the species will prove to choose quite a particular host or, at any rate, to choose between a very few hosts.

In describing the oviposition he says: „The fly turns round, walks backward within striking distance, and then thrusts her ovipositor into the thorax and deposits her egg". As the egg is laid on the abdomen, the purpose of thrusting the ovipositor into the thorax is not to be understood,

unless the fly has paralysed the spider; the author, however, does not say anything on this.

When the larva leaves the host and passes to the web itself, the reason is surely not, that it finds the foundation inconvenient; it does so by sheer instinct; for, in most cases, the size of the host is about the same on the day, it is killed by the larva, as it was, when the larva was tender. Nature has endowed the larva with a never-failing knowledge, which comes to existence simultaneously with the appearance of the warts, and the enormous increase of appetite.

As to the statement of Bignell, that the larva leaves its hold on the silkencord by withdrawing the hooklets into the wart, it is not easily seen, whether he has distinguished between the introsusception of the warts and what he calls withdrawal of the hooklets.

Personally I have not given my attention just to the question, how the threads is disengaged from the hooklets, but if Mr. Bignell means to say, that it is the warts, that are retracted, he is surely wrong, for if the larva will seriously hold the thread, the warts are fully withdrawn into the skin and the thread is not to be wrenched from the larva.

Undoubtedly, the part played by the hindmost segment during the spinning of the cocoon is not that stated by Mr. Bignell. Several times I have seen the cocoon spinning, but the hindmost segment has had nothing to do with the spinning beyond what I have stated: it has afforded a direct support of the threads at the very foundation of the cocoon. And if the question is not precisely of the quadrangular cocoon of the *P. pallipes*, where are then the corners and nooks, into which the head cannot pass and fix the threads?

Taking all in all, however, the work of Bignell is a valuable contribution to clearing up a group of insects highly interesting, and had a rich material been available

to him, there is no doubt but that his statement would have been more copious.

In finishing this investigation, I cannot refrain from hoping, that, where the question is to procure reliable observations of merely biological nature, my little work may be introductory to the future study of the external parasites of spiders and tolerably useful as a guide to this study.

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