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Larval Stages of European Nemopterinae, with Systematic Considerations on the Family Nemopteridae (Insecta, Neuroptera)

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Abstract

Larval development of the European *Nemoptera bipennis* and *Lertha sofiae* have been completed in the laboratory, the morphology of their egg and larval instars are described. New data on their larval behaviour and biology, as embrionary development time, larval feeding preferences, way and number of moultings, strategies in their development time and pupation are given. Some new data on their distribution and biology as flying activity, food, periodicity and number of layed eggs and longevity are noted. Based on obvious differences in larval morphology and biology of Nemopterinae, in regard to Crocinae and other nearest Neuroptera families, some aspects of their systematic position and relationships are commented, and both subfamilies should be considered with family rank.

Key words: Neuroptera, Nemopteridae, *Nemoptera, Lertha,* egg – larval morphology, larval behaviour, Iberian Peninsula, Systematics.

Introduction

The family Nemopteridae is one of the most controversial, interesting and specialized family among the Neuroptera, it is actually divided into two subfamilies with very different morphology and habitats. The Crocinae (with two European genera *Josandreva* Navás, 1906 and *Pterocroce* Withycombe, 1923), which include around 50 species of small size, is distributed in arid and desert zones on the southern borders of the West Palaearctic and West Oriental Region, and dry areas from Neotropical, Afrotropical and Australian Regions. With crepuscular-nocturnal flying activity and troglobious habits, its imaginal and preimaginal biology and morphology is acceptably well known (Tjeder, 1967; Mansell, 1976, 1977, 1980, 1981a, 1981b, 1983a, 1983b; Monserrat, 1983a, 1983b) and its taxonomy, biogeography and phylogeny have recently been revised (Hölzel, 1975; Mansell, 1986).

Whereas Nemopterinae (with two European genera *Nemoptera* Latreille, 1802 and *Lertha* Navás, 1910), amounting almost 100 species, and including some of the biggest and most spectacular within the Neuroptera, having a similar distribution than Crocinae,

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their imagoes are frequently abundant, have brief seasonal emergence periods, crepuscular or diurnal flying habits, and usually with extremely pronounced endemisms restricted to a single habitat. Its taxonomy and systematics still need a general revision, there is very little information on its biology and, curiously, the biology and morphology of its preimaginal stages, in the majority of species, is very poor or remains unknown (Tjeder, 1967; Mansell, 1973).

In this respect, and instead of erroneous, doubtful or too vague and outdated references on preimaginal stages in this subfamily (Brullé, 1832; Rosenhauer, 1856; Kiesenwetter, 1857; Schaum, 1857; Hagen, 1866; Blair, 1921; Navás, 1924a, 1926), some data on the egg is only known about the West Mediterranean *Nemoptera bipennis:* Dufour, 1857; Navás, 1919; Withycombe, 1925 and Monserrat, 1985, about the South African *Knersvlaktia nigroptera:* Picker, 1984 and *Palmipenna aeoleoptera:* Picker, 1987 and some scarce references about the East Mediterranean *Nemoptera sinuata:* Popov, 1963, 1973. First or last larval stage have only been described for the Mediterranean *Nemoptera bipennis:* Navás, 1919 and Withycombe, 1925, *N. coa:* Tröger, 1993, and *Nemoptera sinuata:* Friedrich, 1953; Popov, 1963, 1973, about the Australian *Chasmoptera hutti:* Mathews, 1947, about the Southafrican *Derhynchia vansoni:* Mansell, 1973, and only some data is known about pupae of *Derhynchia vansoni:* Mansell, 1973 and *Nemoptera coa:* Tröger, 1993. Also Monserrat & Martínez forward some information on preimaginal stages from Iberian *Nemoptera bipennis* and *Lertha sofiae,* more fully developed and exposed in the present contribution. No more information exists, and some of this scarce data has been repeatedly reiterated (Navás, 1924b, 1924c; Saz, 1925; Tjeder, 1967; Kis et al., 1970; New, 1989; Tröger, 1993).

The supposed predator behaviour of larvae in this subfamily is evident, due to their aspect, and an edaphic lifestyle has long been suspected (Wheeler, 1929). Both have been confirmed with some of these recent findings, however many other aspects of its biology and behaviour as lifestyle in relation with other animals, life-cycle time, number of instars and moltings, natural nourishment, parasites, have been deduced or remained almost unknown. Larvae have always been found in the ground living freely in loose sand surfaces, at times to a considerable depth (15–25 cm beneath the surface), usually without being able to breed them in laboratory conditions, some possible preys such as small arthropods and Tipulids, Noctuids or Tenebrionids have been suggested, only Popov (1963, 1973) during 10 months in feeding first instars of *N. sinuata* offering it different animal-plant substances and Tröger (1993) succeeded last instars of *N. coa* with wasp, butterfly and fly larvae and pupae. Monserrat & Martínez (1995) conclude the myrmecophily as the possible lifestyle in larvae of this subfamily, breeding all instars of *N. bipennis* and *L. sofiae* with ant larvae as food, observing some similar ecological requirements between Nemopterinae imagoes and grain cropperants.

Pupation has only been observed twice, in the ground, to a depth of 5–10 cm beneath the surface in field or 0.5–1 cm beneath the surface in the laboratory (Mathews, 1947; Mansell, 1973; Tröger, 1993).

In this contribution, new data on imago behaviour, eggs, larvae instars (bred in the laboratory) and cocoon morphology of the *Nemoptera bipennis* (Illiger, 1812) and *Lertha sofiae* Monserrat, 1988 are described, giving new data on the larval biology and behaviour of this subfamily. On the basis of these data, the systematic position of subfamily Nemopterinae as regards to Crocinae and other Neuroptera families is discussed, and their consideration with family rank is proposed.

Material and methods

Eggs of *Nemoptera bipennis* were obtained from gravid females collected at different points in Spain during the last eight years and those of *Lertha sofiae* from specimens collected in Spain: Almería, Balanegra 20. VII. 1991.

Females were individually isolated into plastic boxes of $10 \times 5 \times 5$ cm, in order to obtain eggs. Some drops of water, a few grains of commercial pollen and some fixed flower were introduced into each box. The eggs laid were isolated into small vials to observe their development time. Several were fixed for posterior microscopy studies.

Temperature conditions of the laboratory during the first eight years of unsuccessful attempts to breed them were not noted, but when the adequate way of feeding them was known (Monserrat & Martínez, 1995), the monthly range of the thermic conditions of both years, under which the larve were bred is noted in °C as follow: I: 14–21, II: 10–23, III: 14–25, IV: 16–23, V: 19–32, VI: 15–37, VII: 21–41, VIII: 22–38, IX: 17–30, X: 14–22, XI: 17–23, XII: 7–22. The photoperiod was taken to be a natural month, but in dark: penumbra (shade, not full light), and RH: 40–60%. After birth, larvae were individually isolated into plastic culture boxes of $2 \times 4.5 \times 4.5$ cm, half filled with sand and throughout all their development they were fed on ant larvae burried into the sand. Data on results obtained with other offered preys in Monserrat & Martínez (1995). The larvae move and feed freely within the sand and, in order to get information on molting, every 15 days, the sand was revised to look for possible exuvies.

Field observation on imagoes have been noted throughout our professional activity and faunistical records, here included, mainly belong to the author's collection, but also other material from these Institutions (CPD: Collection P. Duelli, Birmensdorf, MCNM: Museo Nacional de Ciencias Naturales, Madrid, MH: Zoologisches Museum, Hamburg, MP: Museum National d'Histoire Naturelle, Paris, MZB: Museu de Zoología, Barcelona, NHM: Natural History Museum, London, UB: Universidad de Extremadura, Badajoz), whose indicated abbreviations will be used in the faunistical chapter.

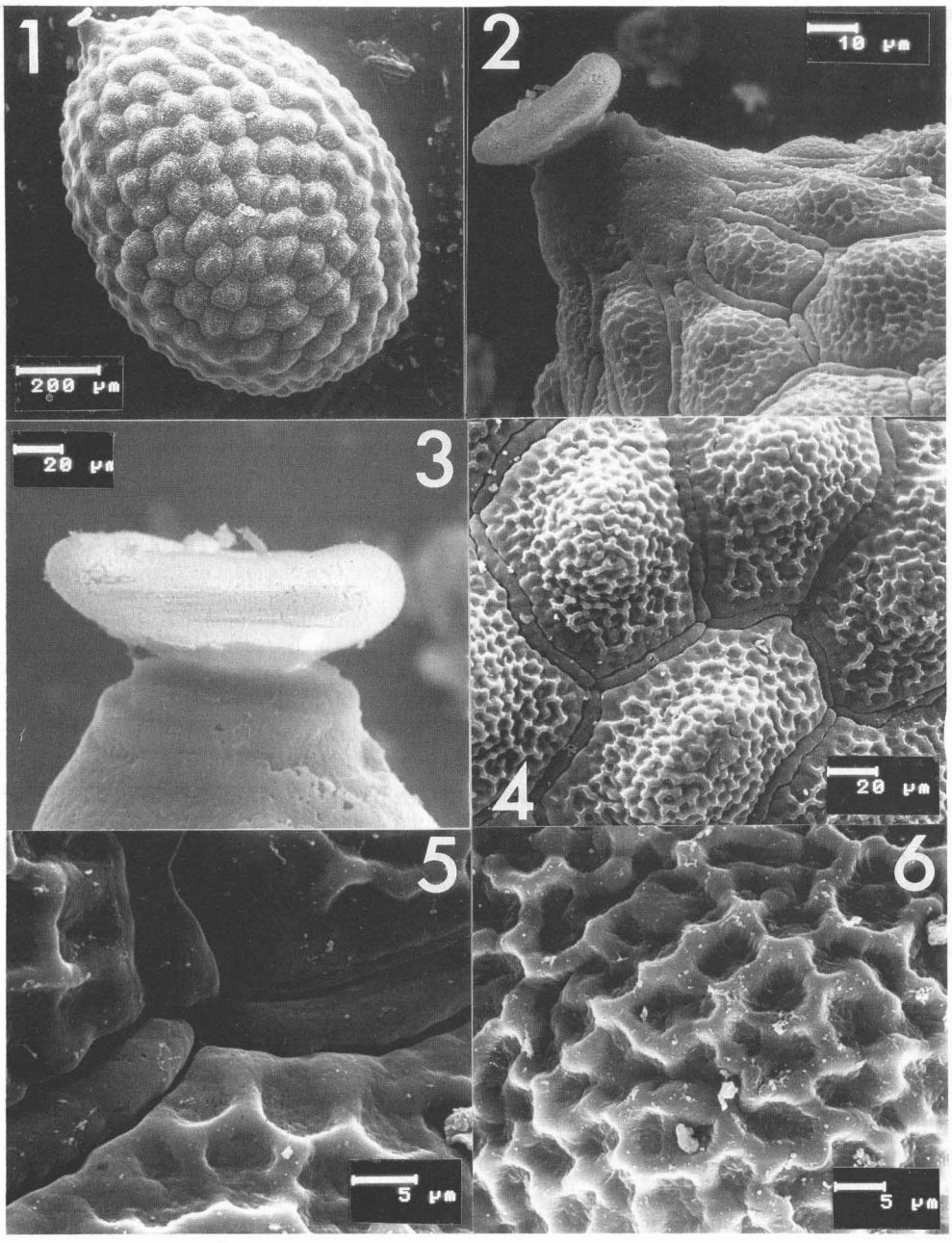
Results and discussions

1. Description of preimaginal stages of Iberian Nemopterinae

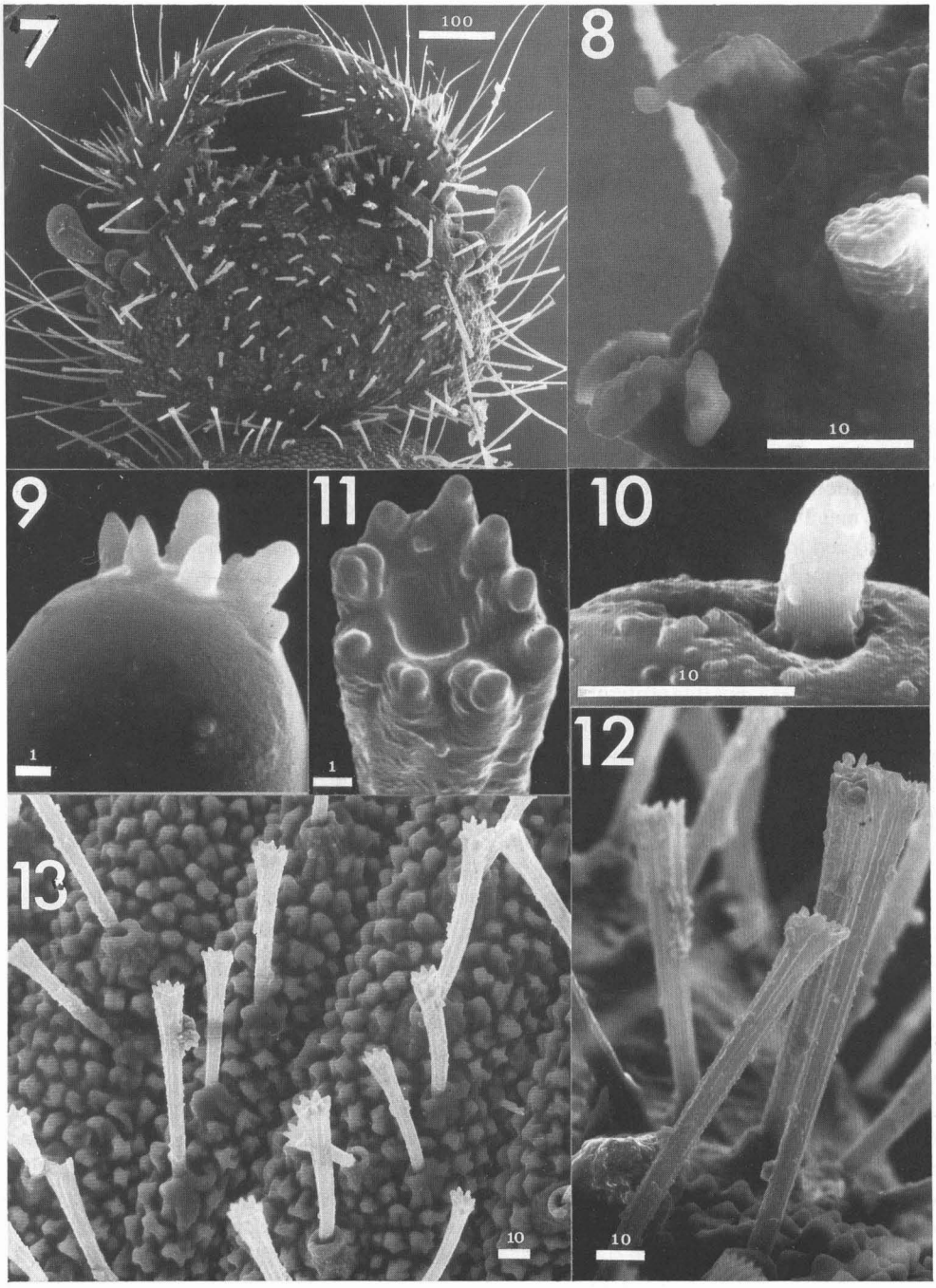
In *Lertha sofiae* the egg is ovoid in shape (Fig. 1), size 1100–1200 µm length, 750–770 µm wide, micropyle conical with a discoidal and conspicuous apex (Figs 2, 3), surface of chorion covered with convex ovarian follicle cell impressions, irregularly hexagonal and bordered by subcylindrical crests (Fig. 4–6). White yellowish when laid, rosaceous some days later and dark greyish prior to hatching. The egg of *Nemoptera bipennis* were described by Dufour, 1857; Navás, 1919; Withycombe, 1925 and more fully by Monserrat, 1985, but it must be added that its colour is light green at first, brown-rosaceous with white conspicuous embryonic stripe later and dark greyish at the end, non fertil eggs are whiter or yellowish.

In both species the position of the larvae prior to hatching is with the head ventrally folded onto thorax and abdomen, and the oviruptor fixed on anterior margin of vertex, between mandibles. In *Lertha sofiae* the strongly chitinized and brown oviruptor has an aspect of a fusiform plate, more chitinized at margins and with two strong, triangled and divergent denticles (Figs 14, 15), remaining fixed by membranes to anterior margin of the biggest part of the shell. The abandoned shell is translucent vivid white, with micropyle brownish. In *Nemoptera bipennis* oviruptor is very similar, but wider as Withycombe, 1925 and Figs 22, 23 show.

Knowledge about the eggs of Nemopterinae is very scarce, spherical in *Nemoptera,* more ovoid but with very similar chorionic morphology in *Lertha* (Fig. 1) and very elongated oval and with different chorion surface in other genera as *Knersvlaktia* and *Palmipenna.* The presence of sponge-like micropyle and aeropyles on chorion is well known in Crocinae but not



Figs 1–6
Egg of *Lertha sofiae*. 1, general aspect; 2, micropylar area; 3, micropyle; 4, aspect of chorion alveoles; 5, particular of their border crest; 6, particular of surface ovarian follicle cells impressions



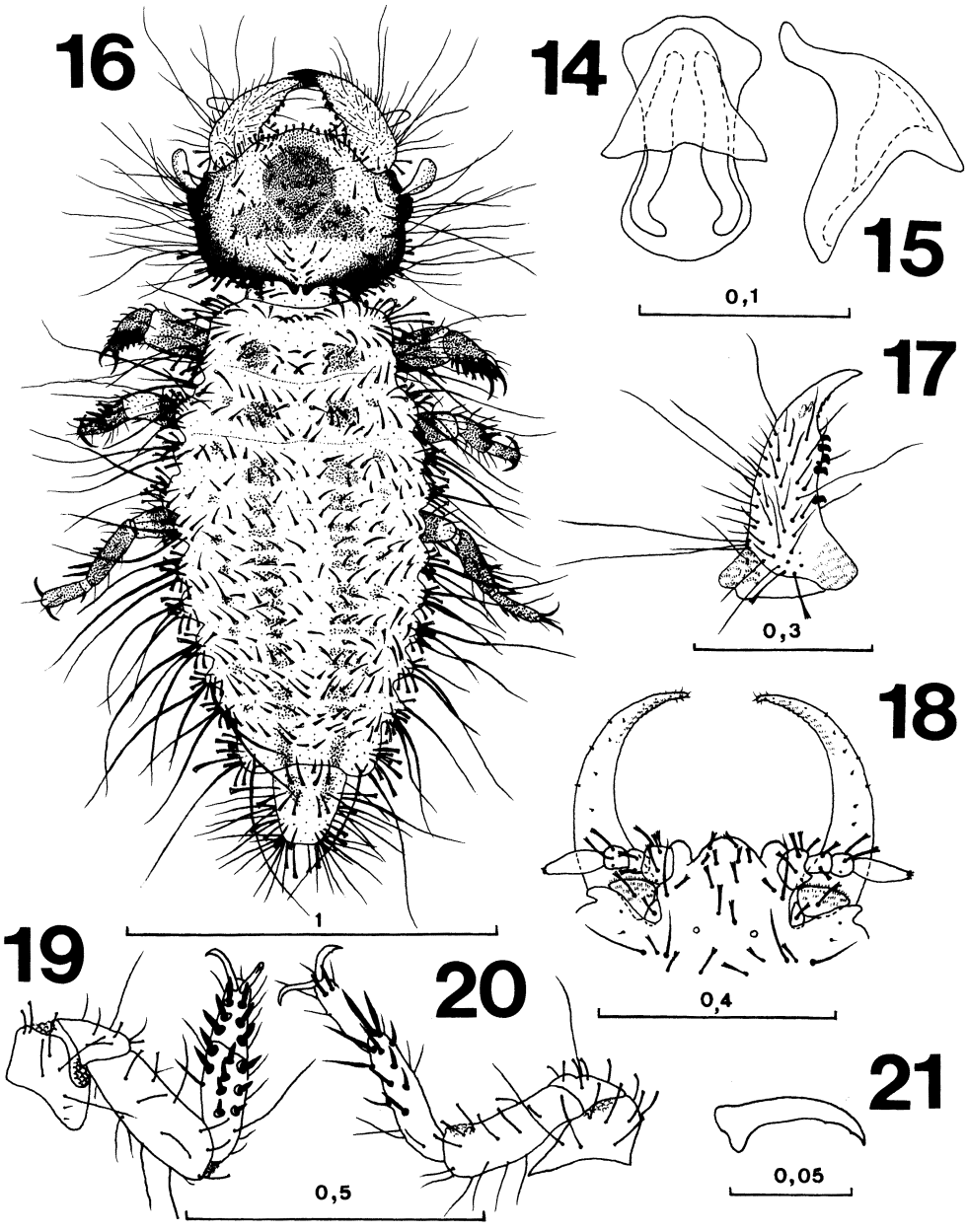
Figs 7–13
Just born larva of *Lertha sofiae*. 7, general aspect of head, dorsal; 8, setae as teeth of inner mandibular margin; 9, tip of maxilar palp; 10, tip of antenna; 11, tip of dorsal head dolichaster; 12, dorsal dolichasters of terminal abdomen segments; 13, dorsal dolichasters of anterior abdominal segments. Scale in µm

in Nemopterinae and the oviruptor is known in Nemopterinae but not in Crocinae and for hatching, the chorion is ruptured along a complete paraequatorial cut in two parts, 1/3 length for micropylar pole and 2/3 for the rest, different as is known in most Crocinae (Withycombe, 1925; Tjeder, 1967; Picker, 1984; Mansell, 1977, 1980, 1981a, 1981b; Monserrat, 1985).

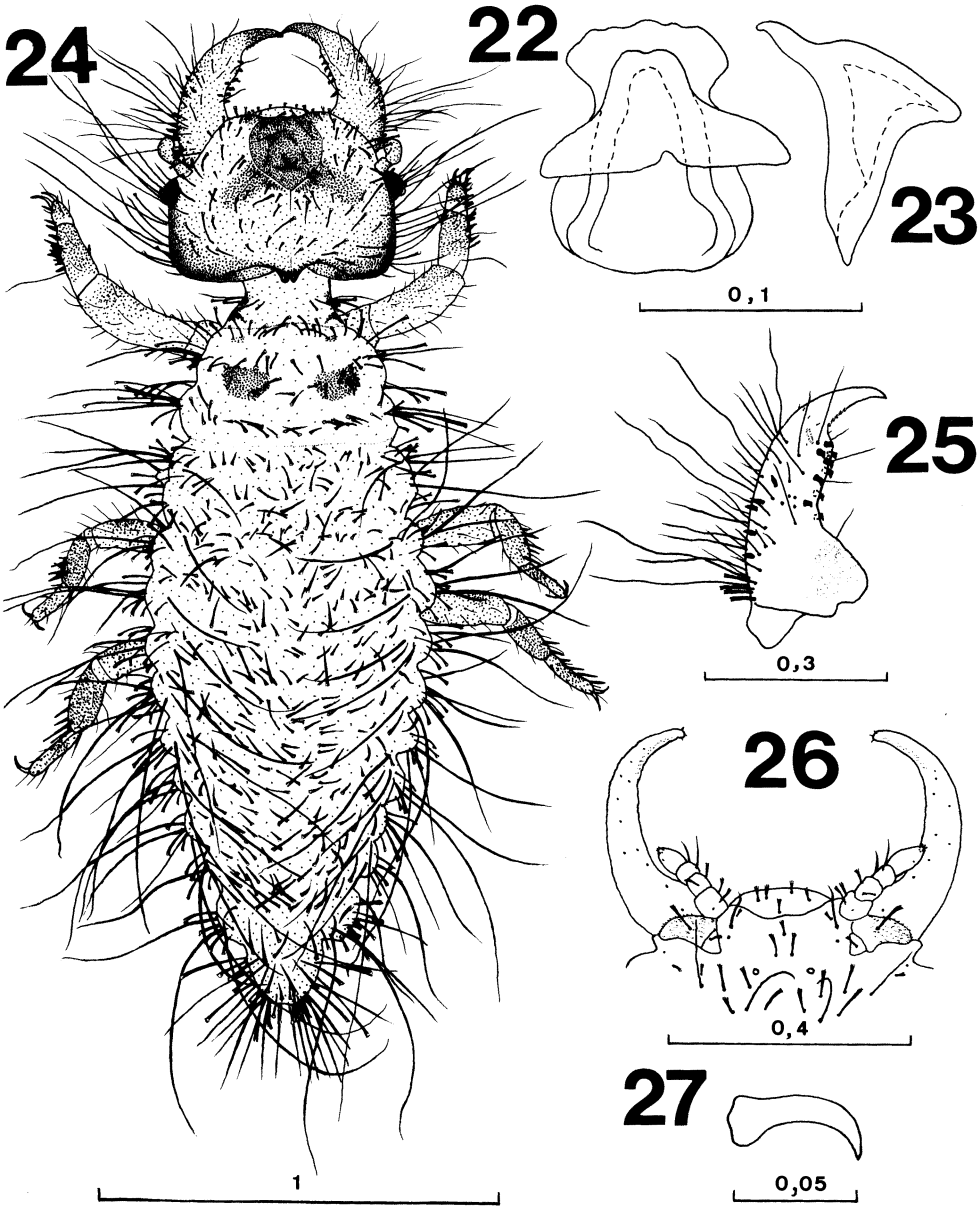
In *Lertha sofiae* the just born larva has a general aspect as Fig. 16: Head hairy (Fig. 7), quadrangular, light brown, darker in lateral and posterior margins, in a dorsal triangular shape mark and in the ventral hind half (Fig. 16). Epicraneal structure Y-shaped (Fig. 16) and lateral suture on external margin extending under estemata to hind margin of labium. Dolichasters dark brown, infundibiliform (Fig. 11), setae dark brown, longer setae terminal lighter, both frequent and placed as show Figs 7, 16. Eyes dark, each one comprising seven stemmata, one ventral and six dorsal (five in a dorsal arch and one central). Antennae pale brown, darker externally, two segmented, basal segment barrel shape with a thin and short ventral seta, distal segment claviform with an apical short and thick seta (Fig. 10), a structure exist in the inside, similar to an invaginated seta, and is not externally visible. Mandibles strong, curved (Fig. 17), brown reddish with apex orange, macrotrichie as teeth on the internal margin (Fig. 8) in three rows, one dorsal with 3, one medial with 2 (the biggest) and one ventral with 3–4 (the smallest), apex of mandible with two sensorial pits (one dorsal subelliptic, biggest and one ventral fusiform) and internally with light rows of little denticles, basal part of mandible with arched rows of microtrichie (Fig. 17). Maxillae curved and lightly denticled at internal apex (Fig. 18), cardo and stipe each one bearing a dolichaster. Labium reduced to a single medial plate, palps four segmented, last one fusiform, sensorial haired tip (Fig. 9).

In *Nemoptera bipennis* the just born larva was "described and figured" by Navás, 1919 and Withycombe, 1925, but it is preferable to carry out a more detailed description. It has a general aspect as Fig. 24, very similar to those of *L. sofiae,* but more elongated. Head with rugous integument, with dolichasters of two obviously different sizes, these and setae dark brown, both frequent and placed as shows Fig. 24. Eyes dark, stemmata as *L. sofiae.* Antennae as *L. sofiae.* Mandibles strongly curved (Fig. 25), brown with apex redish, macrotrichia as teeth on the internal margin as *L. sofiae* but more in number (8–10), dorsal and external face with setae as teeth (Fig. 25). Maxillae and labium as in *Lertha sofiae* (Fig. 26).

In *Lertha sofiae* thorax and abdomen are pale brown, dorsally with two rows of isolated reddish brown marks at each side of middline (Fig. 16), ventrally pale uniform. Small lateral tubercles bearing 6–7 long setae in thorax segments, 3 in the abdomen, last but one 2 and conical last one with a panache of shorter setae (Fig. 16). Dolichaster dark brown, also infundibiliform, dorsal ones biggest and placed from the lateral tubercles to middline in a double arched row of 8–10 the anterior one and 12–14 the posterior one (dorsally) and of 10–18 the anterior one and 10–12 the posterior one (ventrally), more abundant on thorax and more uniformly disposed on last segments and in all ventral face. Legs are brown, darker, shorter and stronger the prothoracic, bearing strong and dark digger setae as spines, on tibiae and tarsus (one dorsal in each segment, and ventrally in three rows, one medial with 4 on tibiae and two lateral with 3 on tibiae and 3 on tarsus) (Fig. 19). Meso- and metathoracic legs also with spines, but thinner, longer and always on ventral face, 2 at the apex of tarsus and in four rows on tibiae, two external of 3–4 and two internal of 3–2 (Fig. 20). Tarsi one-segmented, terminating in paired claws bearing two small notches on the inner side (Fig. 21). At the end of this instar, head capsule and cephalic and thoracic appendages are darker than just born larvae. In *Nemoptera bipennis* the thorax and abdomen is pale cream brown, dorsally with two dark brown spots on pronotum (Fig. 24) and two rows of isolated, almost imperceptible light



Figs 14–21
First instar larva of *Lertha sofiae*. 14, oviruptor, dorsal; 15, ditto, lateral; 16, general aspect, dorsal; 17, mandible, dorsal; 18, maxillae and labium, ventral; 19, fore leg, ventral; 20, hind leg, ventral; 21, claw, lateral. Scale in mm.



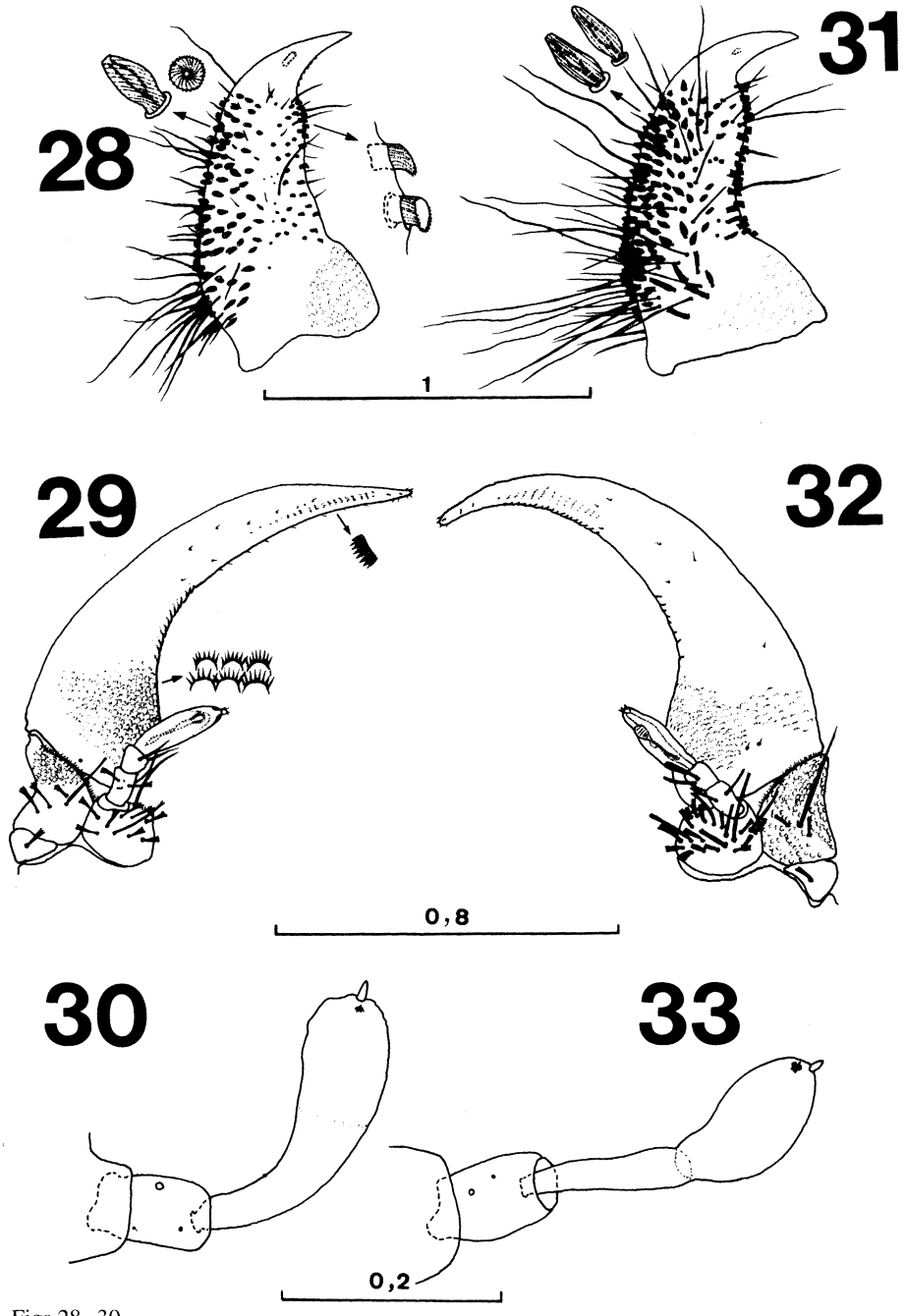
Figs 22–27
First instar larva of *Nemoptera bipennis*. 22, oviruptor, dorsal; 23, ditto, lateral; 24, general aspect, dorsal; 25, mandible, dorsal; 26, maxillae and labium, ventral; 27, claw, lateral. Scale in mm.

brown marks at each side of the middline, ventrally pale uniform. A row of small lateral tubercles bearing 1 long seta in mesonotum and metanotum, and 2, folded on the abdomen, in the abdominal segments, a more external row of tubercles bearing 1 seta on pronotum, 2 in mesonotum and metanotum, and 2–3 in the abdominal segments, last segments conical with a

panache of shorter setae more abundant ventrally and as dolichasters dorsally (Fig. 24). Dolichaster on the thorax and abdomen are dark brown, also infundibiliform, dorsal and caudal ones biggest and placed from the lateral tubercles to middline in a double arched row of 10–24 setae on thorax and 20–24 on abdomen, more uniformly disposed on last segments, in ventral face setae are dispossed on a median stripe in thorax and in two rows 24–44 setae on abdomen, one on each side longer as a seta. Legs as *L. sofiae* with 2–4 more spines on tibiae. Claws without small notches on the inner side (Fig. 27). At the end of this instar, head capsule and cephalic and thoracic appendages are also darker than just born larvae, and some longitudinal brown stripes are designed on dorsum (Fig. 34).

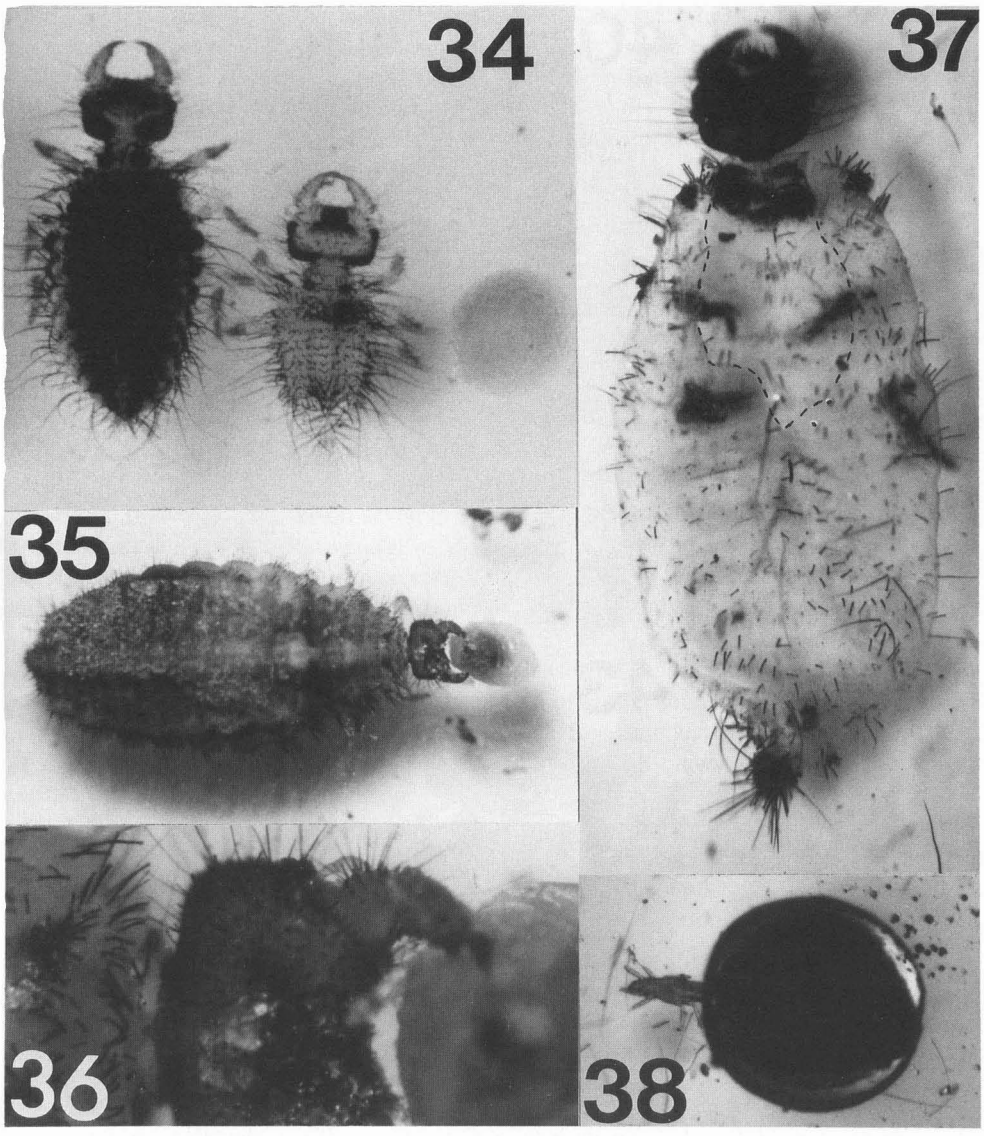
Second instar similar to first, but body less globular and more elongated. Dolichasters and setae proportionally shorter, specially in head and last abdominal segments, in similar position but more abundant and more ring disposed. Head capsule darker, its dark lateral and posterior margins more extended to epicraneal suture. Antennae proportionally smaller and last labial palp segment seems apically divided. Structures "mandible-shaped" on hind ventral margin of seventh segment already formed. Claws of forelegs stronger than mid-hindleg. Spiracles more conspicuous. Sutures as in first instar. In *Lertha sofiae* tergites and sternites of prothorax more sclerotized and patents and longitudinal marks of dorsum darker and more continuous, specially in two last segments. Mandible with many macrotrichie in dorsal and internal face. In *Nemoptera bipennis* there are more setae as denticles on inner mandible margin and more setae as spines on its lateral and dorsal face. General colour as shall be describe on third instar, with longitudinal rows of dark spots on dorsal face and two longitudinal rows of dark spots on ventral two first and seventh abdominal segments.

Last instar in *Lertha sofiae* (Figs 39–41) with head square, flat dorsally and very convexe ventrally, with Y-shaped epicraneal suture more visible than lateral one along its external margin and hind margin of labium, brown coloured with a reversed T-shaped dorsal shadow darker, lateral and hind margins dark brown. Trichosors dark brown, dorsal ones stronger and lanceolated, thin, longer and frizzled laterally and beginning to appear as dolichaster on anterior and posterior regions, ventrally trichosors limited to a wide central stripe, as dolichaster the anterior ones and longer the posterior ones, microtrichie specially frequent on hind area of head. Eyes dark, haired, with very convexes stemmata placed as in just born larvae. Antennae (Fig. 30) pale brown, two segmented, basal segment short, subcylindrical, distal segment clavate with an apical conical seta, behind which there is a tegumentary sensorial structure. Mandibles (Fig. 28) curved and strongly sclerotized at the tip, bearing small denticles in its internal margin, setae predominantly as teeth on inner margin, lanceolated and hollow in the middle on the dorsal area and as usual on the external face, microtrichia specially frequent on basal inner area. Maxillae (Fig. 29) reduced, curved and with sensoral microtrichia and short setae on mid apical, cardo with one dolichaster and stipe with 3–4 dolichasters and a long seta, microtrichie also on stipe and basal palp, which is four segmented, second and third segment with two setae, last one with apical hyaline papillae, sensorial palpimaculae conspicuous, as a drop distally and fusiform basally, labium reduced to a single medial transverse plate. Thorax and abdomen pale cream brown, dorsally with a wide central stripe pink-orange, more obvious on thorax, flanking out a longitudinal stripe of grey-brownish stains, another irregular and more external maculated stripe and a third striped one on abdominal spiracles (Fig. 39). Ventrally two longitudinal rows of grey-brownish spots on both sides of midline (Fig. 40). Dolichaster also infundibiliform, distally as a 9 points star, wide ring located, dark brown and short, longer in last segments. Distinct sclerites only present in anterior proesternum, rudimental in pronotum, and pleural sclerites strong in legs insertions. Legs unequals as first instar, but diger setae



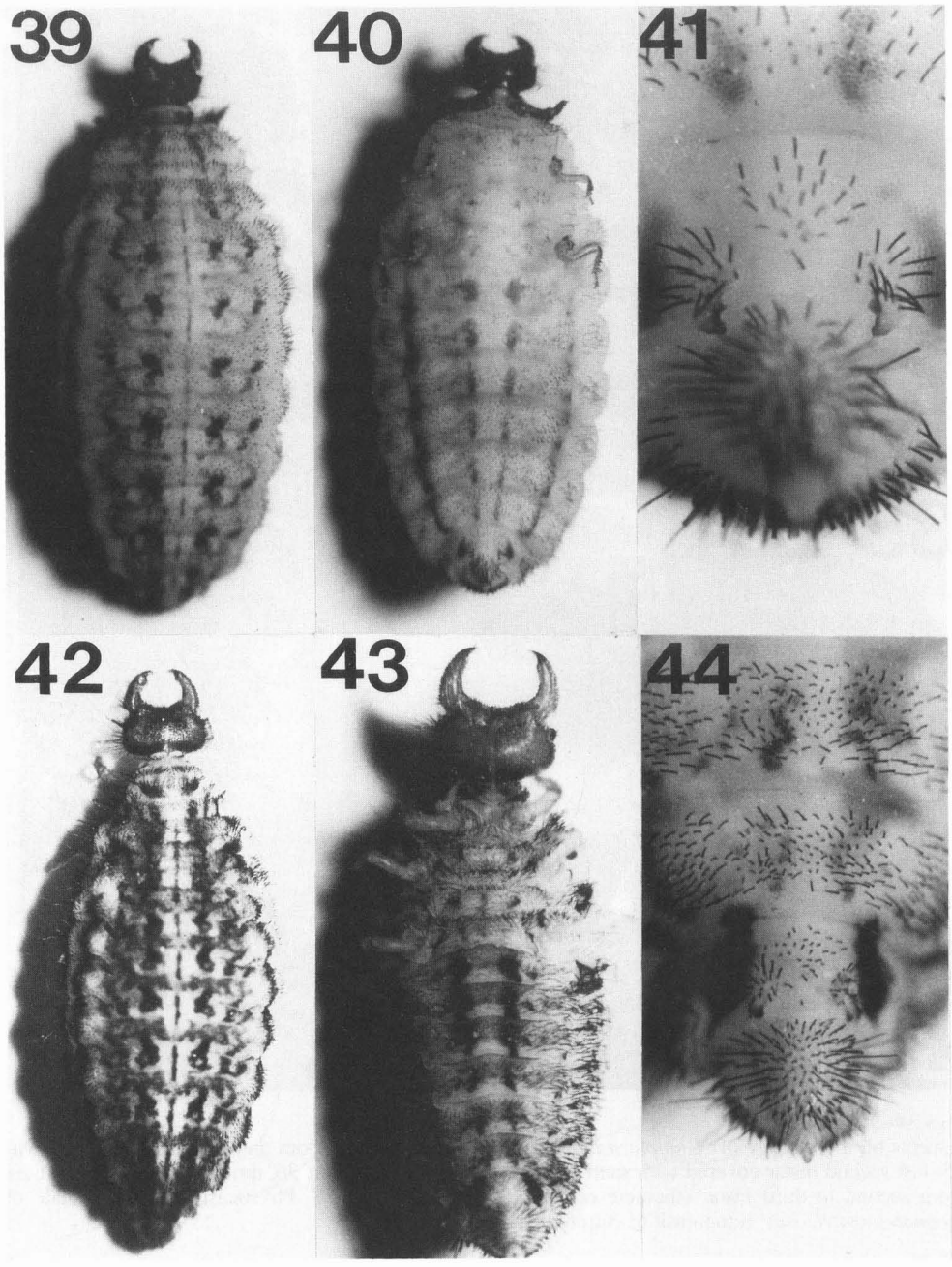
Figs 28–30
Third instar larvae of *Lertha sofiae*. 28, mandible, dorsal (some setae magnified); 29, maxille and labial palp, ventral (some microtrichie magnified); 30, antenna, dorsal.

Figs 31–33
Third instar larvae of *Nemoptera bipennis*. 31, mandible, dorsal (some setae magnified); 32, maxile and labial palp, ventral; 33, antenna, dorsal. Scale in mm.



Figs 34–38
Aspects on the biology of *Nemoptera bipennis* larvae. 34, egg, just born and eight months age larva; 35, last second instar covered with sand particles, eating an ant larva; 36, ditto, particular; 37, exuvia from second to third instar (thoracic ecdisis suture delineated); 38, Physogastric gravid female of *Pyemotes ventricosus,* ectoparasit of cultured Nemopterinae larvae

proportionally shorter and stronger, and claws abraded and appically truncated, foreleg with digger setae stronger, in four rows, two external of four and two internal of five and six, tarsus with two rows of three, digger setae of hindlegs similar to first instar, but inner rows with six setae and tarsal setae little. A distinct dark and chitinized "mandible"-shaped structure is evident on ventral hind margin of 7th abdominal segment (Fig. 41).



Figs 39–41
Developed third instar larva of *Lertha sofiae*. 39, dorsal aspect; 40, ventral aspect; 41, last abdominal segments, showing chitinized "mandible"-shaped structure on hind margin of 7th abdominal segment, ventral.

Figs 42–44
Medium developed third instar larva of *Nemoptera bipennis*. 42, dorsal aspect; 43, ventral aspect; 44, last abdominal segments, showing dark marks and chitinized "mandible"-shaped structure on 7th abdominal segment, ventral.

In *Nemoptera bipennis* last instar (Figs 42–44) with square head, also flat dorsally but less convex ventrally, with Y-shaped epicraneal suture as visible as lateral one, dark brown with similar marks darker than prior instars. Trichosors dark brown, dorsal ones stronger and as spines, other setae thin, longer and frizzled laterally, ventrally trichorors limited to a wide central stripe, longer on hind half. Eyes dark, haired, with very convexes stemmata, placed in two rows of three unities on dorsal half and one isolated on ventral half. Antennae (Fig. 33) pale brown, two segmented, basal segment short, subcylindrical, distal segment seems subdivided, but without articulation between the two differenciated parts, one subcylindrical, basal and other subovoid, distal, also with an apical conic seta, and a tegumentary sensorial structure. Mandibles (Fig. 31) curved, as in *L. sofiae* but bearing much more small denticles as teeth in its internal margin, and microtrichia on dorsal and external area. Maxillae and labium similar to *L. sofiae* (Fig. 32). Thorax and abdomen pale brown, dorsally with central stripe flanking out three longitudinal stripes of dark brow stains, the mid-one more irregular and the external darker, joining on the eighth segment (Fig. 42), on lateral margin, there is a fourth fragmented and striped row in abdominal spiracles line. Ventrally two longitudinal rows of brownish spots on both sides of midline, less marked on thorax and bigger on seventh segment (Fig. 43), near to the "mandibles"-shaped structure which is evident on ventral hind margin of seventh abdominal segment (Fig. 44). Dorso-lateral tubercles almost imperceptible, losing their setae, lateral tubercles are convex and bearing their setae. Dolichasters infundibilimorms, distally as 10–11 points star, limited to trasversal areae, dark brown and short, longer in last segments, in the last visible one as spines on distal half. Ventrally dolichasters in a dense and cuadrangular area, more dispersed on thoracic segments, also as spines on distal half of eighth segment. Distinct sclerites only perceptible in anterior proesternum and in pronotum. Legs unequal as in first instar, but digger setae as prior, but proportionally shorter and stronger, and claws abraded and so apically truncated.

As in Nemopterinae egg morphology, the knowledge on their larvae is very poor and sometime too superficial, so comparative studies are not possible in detail, Tröger (1993) made a light comparation among different larvae then known. The genus *Lertha* seems very similar to *Nemoptera,* but there are some differences in external colouration and cheatotaxy (Figs 16–33, 39–44), position of stemmata, denticulation of mandible (Fig. 28, 31) and morphology of antennae (Figs 30, 33) seem good characters to differenciate them. Respecting to other known *Nemoptera* species, larva of *Nemoptera bipennis* seems darker and some small differences in the maxillar chaetotaxy and antennae segmentation seem be detected from description of *N. coa* larva (Tröger, 1993).

2. Biology and behaviour of larvae

The biology and behaviour of Nemopterinae preimaginal stages are almost unknown. So the data here included based on the laboratory culture of two Iberian species seem to be interesting.

Eggs, which are not adhesive, were laid singly during night in number by female: 0–13, $\bar{x} = 6$ in *L. sofiae,* at the same time, and 0–51, $\bar{x} = 25$ in *N. bipennis,* laid during several days, as is shown in Table 1, Monserrat (1985) records till 85 eggs in *N. bipennis.* Data in other species are scarce, Popov (1963) recorded 6 non-adhesive eggs for *N. sinuata* and Picker (1984)

Table 1
Number of eggs (N) laid day by day from female captured to its death (+) and development period (DPD) in days

L. sofiae	Capt.day	2nd	3rd	4	5	N	DPD
spec. 1	0	1	(+)			1	(+)
spec. 2	0	13	0	(+)		13	20–22
spec. 3	0	0	0	(+)		0	–
spec. 4	0	7	0	0	(+)	7	(+)
spec. 5	0	11	0	0	(+)	11	22–24

N. bipennis	Capt. day	2nd	3rd	4th	5th	6th	7th	8th	N	DPD
spec. 1	0	12	12	12	8	0	(+)		44	18–20
spec. 2	0	9	17	9	(+)				35	18–21
spec. 3	0	10	31	10	(+)				51	18–21
spec. 4	0	2	6	10	1	(+)			19	18–21
spec. 5	0	2	7	3	(+)				12	18–20
spec. 6	2	3	17	7	3	(+)			32	18–21
spec. 7	0	6	0	(+)					6	18–20
spec. 8	0	7	8	5	(+)				20	18–21
spec. 9	0	0	0	(+)					0	–
spec. 10	0	0	8	(+)					8	19–21
spec. 11	0	13	13	12	11	(+)			49	18–20
spec. 12	2	10	20	12	(+)				44	18–20
spec. 13	0	0	1	(+)					1	19
spec. 14	0	3	3	14	2	3	0	(+)	25	18–19
spec. 15	0	14	3	6	6	1	(+)		30	18–19
spec. 16	0	0	0	18	5	0	0	(+)	23	18–19
spec. 17	0	6	6	12	3	5	(+)		32	18–19
spec. 18	0	0	18	(+)					18	18–21

recorded 13 adhesive eggs for *Knersvlaktia nigroptera,* also adhesive eggs are recorded for *Palmipenna aeoloptera,* by Picker (1987), but number was not indicated.

Incubation period from 20–24 days in *L. sofiae* and 18–21 days in *N. bipennis,* as shows Table 1, not all eggs were fertile. The only known data on their embrionic period time, was recorded, without much precision, by Navás (1919) for *N. bipennis,* also Popov (1963) record 20 incubation days at 30 °C for *N. sinuata.*

Just born larva remains some minutes resting and later is active. The larvae dig into the sand with a mechanical and rhythmic motion, opening the way, head first, with closed mandibles as a shovel, but specially burrowing with fore legs and pushing with the other legs. Usually reaching the bottom of the culture-box and remain quiet so burried during all its development. No epigean behaviour in *L. sofiae* larvae has been observed, but sometimes larvae of *N. bipennis* were found on sand surface and exceptionally a larva was found attached to the box blind which suggest a certain climbing ability. Cannibalism was never observed in *L. sofiae* larvae, but it was seen in *N. bipennis* larvae submitted to food scarcity. Thigmotaxis is evident and a certain positive phototaxis have been checked up. The larvae disturbed remain motionless, imper-

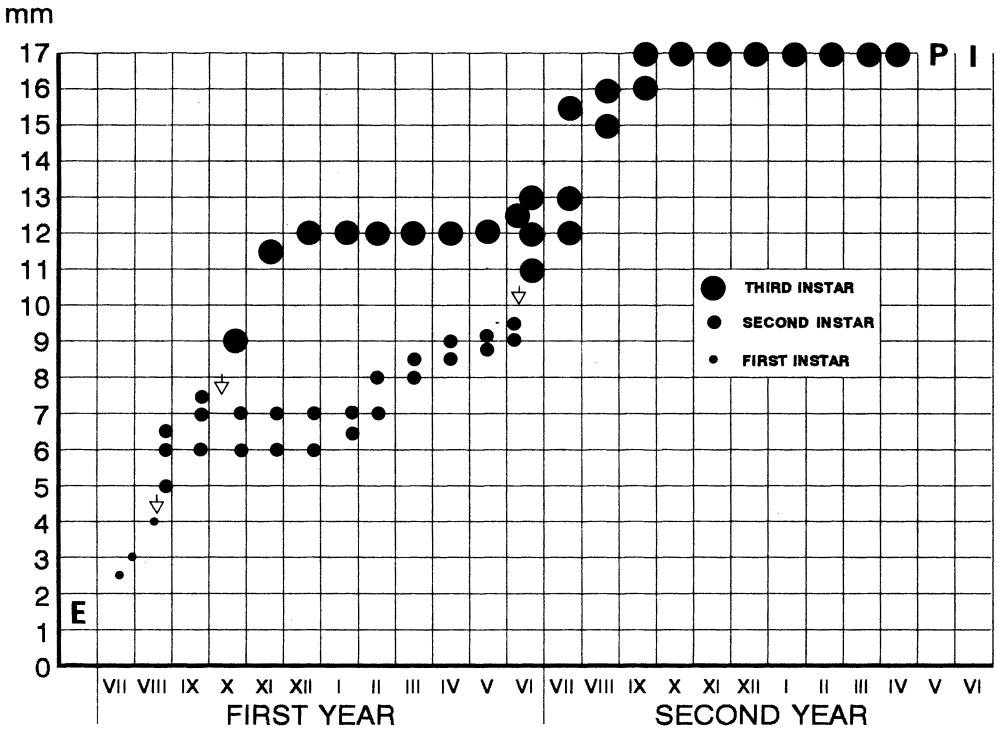
turbed and passive, died like, for hours in any posture. Data of the digging behaviour, are similar to those noted in other known species (Mathews, 1947; Popov, 1963; Mansell, 1973), and some of the here related data on *N. bipennis* are very similar to those recorded by Tröger (1993) for *N. coa.*

The most of preys used as possible food were rejected, but ant larvae were particularly predated, and only larvae fed with ants larvae grown regularly, faster and showed a more appreciated activity, concluding its development (Monserrat & Martinez, 1995). Motion stimulous of prey was necessary to predation and motions of ant larvae used as food, stimulates positively the moving of cultured larvae toward it, dead or motionless preys were hardly detected and predated. Larva usually bites the ant larva once only and sucks its fluids (not its gut fluids) for feeding, some predigestive, paralizing or toxic secretions must be applied, because the prey stops moving in a few seconds. During the suction, larvae are motionless with head and mandibles up turned and antennae and palps down-back turned, usually moves head during suction, creeping the prey. Type of suggested or used preys in Nemopterinae larvae have already been commented and some of the here related data agree with those recorded by Tröger (1993) for *N. coa.*

Just before of the ecdysis time, some larvae have been observed with the abdominal tip fixed to the botton of the culture-box with own secretions. For the ecdysis, the tegument is broken in head throughout the epicraneal and lateral sutures and on the dorsal middline of thorax. As first tested results, two moults and three instars have always been observed (Table 2), first moult very premature (two months after born), second one almost one year later, both in summer (warmest time). Faster growing during first instar and after each moult (Table 2), less growing at the end of its last larval period when they do not grow, but overwinter, and during the autumn-winter of both years (coldest time), when food availability in nature is probably smaller. One specimens got two moults at first year (Table 2), suggesting the occasional possibility of reaching a shorter development and to mix genome from two different generations, as Tröger (1993) suggest for *N. coa* and some of the here related data agree with those recorded for last instars of this species. Growing mensurements and time between moults during the larvae' development was shown by Monserrat & Martinez (1995) for *L. sofiae,* and those for *N. bipennis* are shown in Table 2.

At the end of the development the larvae start the pupation, making a soft spherical silk cocoon (12 mm in diameter for *L. sofiae* and 13 mm in diameter for *N. bipennis*) with accreted sand particles similar to Myrmeleontidae, but much less silk paded internally, spending 7–10 days to complete its construction. The cocoon of *N. coa* and *D. vansoni* seem smaller (Mansell, 1973; Tröger, 1993). Time as pupae could not be noted cause a virulent infestation of "hay itch" mites *Pyemotes ventricosus* (Newport, 1850): Acari, Pyemotidae (Fig. 38), a mite usually recorded as ectoparasite of development stages of Lepidoptera, Coleoptera and Hymenoptera (Owen Evans et al., 1961; Hughes, 1976, etc.), mites of this genus were used as biological control of different insect pest, also of fire ants (*Solenopsis invicta* Buren), and larvae and pupae of ants are used to breed this parasite (Gerson & Smiley, 1990; Hölldobler & Wilson, 1990), the infestation into culture-boxes could come through some field ant-larvae used as food. Different families of mites as *Pygmephoridae, Tetranychidae, Erythraeidae, Thrombidiidae* etc. have been recorded as parasites on Neuroptera (Hartzell, 1918; Smith, 1922; Killington, 1936; Principi, 1956; Parfin & Gurney, 1956; Aspöck et al., 1980; Pantaleoni, 1983; Hagley & Miles, 1987), but previous records do not exist on Nemopterinae mite parasites, nor this mite family in Neuroptera. Infested larvae and pupae were immobilized and its development was interrupted, however imagoes fly in nature

Table 2
Time-growing graph (linear body length) of three specimens of *Nemoptera bipennis* from just born larvae, to their pupation (P), showing in one specimen a certain posibility of overlap two generations. (Arrows show the ecdysis from an instar to other. E: egg, P: pupe, I: imago).



30–40 days later (Table 2), and some data can be applied from those recorded by Tröger (1993) for *N. coa.*

3. Biology and behaviour of imagoes

The biology of imagoes in Nemopterinae is much more unknown than in Crocinae. Usually restricted to a single habitat, with pronounced endemisms, the most of species have been scarcelly collected, usually prefer arid, sandy or stony countries, with mainly low vegetation, usually crepuscular or nocturnal in their habits, other wings pigmented genera as *Nemoptera, Palmipenna* or *Knersvlaktia* flying in bright sunshine. Usually feed pollen and have poor flight ability (Tjeder, 1967; Picker, 1984, 1987). Other information on the biology, habitat preferences, seasonal and altitude distribution for European genera, was noted by Popov (1970) and Aspöck et al. (1980).

Imagoes of *L. sofiae* only have been associated to windy and dry subdesertic coast plains and hills, from 10–300 m hight, only during 10–15 days a year always in July, brief seasonal emergence periods and narrow habitat preference in Nemopterinae have usually been recorded

(Tjeder, 1967; Picker, 1984). Imagoes of *N. bipennis* are locally frequent and usually flying at the end of spring, sooner or later according with latitude and altitude, are associated to open, sunny and not wet plains, hills and mountains, from coast to almost 2000 m, in habitats with abundant low or annual vegetation, from big wood clearings to coastal dunes and always in habits under mediterranean influence.

Imagoes of *L. sofiae* are active flying only for one hour or less, just between sunset to almost night dark, in the short wind pause between see breeze (during day) and continental breeze (during night), no specimen have been seen flying at day light and none have been collected at light-trap, even in the same place and date when, some minutes ago, flying specimens have been observed. The positive phototropic to light in the evening has been recorded in other genera (Tjeder, 1967). Whereas, imagoes of *N. bipennis* fly during daylight and are specially actives to hiter hours. Wing coloured Nemopterinae have this diurnal activity (Tjeder, 1967; Popov, 1970; Aspöck et al., 1980; Picker, 1984, 1987).

The almost transparent imagoes of *L. sofiae* are not easy to observe, specially for the spare light in this moment, fly fast and irregularly over low bush, resting on them (probably feeding, but no many flower existing around during the flying period) with its dark brown hind wings hanging, but when some danger is detected, hind wings are opened at maximum, making its silhouette more disruptive, if danger increases, it lifts its hind wings to make the other part of the body less vulnerable to an eventual attack. Whereas, the well coloured yellow-brown wings of *Nemoptera* agrees with its diurnal activity, and the disruptive pigmentation of its wings imagoes of *N. bipennis* remain motionless on vegetation if danger is present. The use of wings as cryptic, as visual signalling function and anti-predator roles again robber flies was studied in *Palmipenna* and *Knersvlaktia* by Picker (1984, 1987) and Picker et al. (1991, 1992), the robber flies *Neomoctherus (Cerdistus) flavicornis* (Ruthe, 1831) was very frequent in *L. sofiae* habitat, and *Dasypogon (Selidopogon) diadema* (Fabricius, 1781) was frequent in some *N. bipennis* habits, and it was seen attacking this species.

No pollen have been found in the gut of the only dissected specimen of *L. sofiae,* but large amount of pollen of different plant families have been found in the gut of some dissected specimens of *N. bipennis,* belonging to Campanulaceae *(Campanula, Jasione)* and Compositae *(Bellis, Cardus, Helianthus, Taraxacum),* Caryophyllaceae, Cruciferae, Leguminosae and Gramineae, also some of Conifers and spores of molinials fungus. Monserrat (1977) record imagoes of this especies feeding on flowers of *Lavandula* and *Sarothamnus* and we have seen specimens apparently libating on Caryophyllaceae (*Silene scabriflora* Brot.), Compositae (*Andryala integrifolia* L.), Labiatae (*Lavandula stoechas pedunculata* Miller, *Thymus mastichina* L.), Umbelliferae (*Tapsia villosa* L.) and Campanulaceae (*Jasione montana* L.), usually feeding directly on flowers and also sucking pollen stuck to its fore legs. Feeding large quantities of different kind of pollen in many Southafrican genera (Tjeder, 1967), and on Compositae and associated to two kinds of pollen, probably Mesembryanthemaceae, have been recorded in *Palmipenna* by Picker (1984, 1987).

No mating has been observed, and no spermatophore, present in *Barbibucca* and *Nemopterella* (Tjeder, 1967) have been detected in Iberian genera. We have not observed in nature females laying eggs, but observations on female on substrate agree with the possibility of laying on the ground as Picker (1984, 1987) records in other species. Number of laid eggs in laboratory have been commented and are indicated in Table 1. Longevity of imagoes has not been recorded, but some data in laboratory (probably greater in nature), can also be extracted from Table 1.

4) Distribution and new faunistics records

Two genera and five species are known in Europe, of these *Lertha sofiae* is only known from S.E. of the Iberian Peninsula (Monserrat, 1988) and new records now annoted, and *Nemoptera bipennis* was considered as an Iberian species, with a wide distribution on it, but records in north Iberian areas with Eurosiberian influence would must be checked, the species have also been collected and recorded long time ago in South of France (Marseille) and in North Africa (Algerie) as *N. lusitanica* or *N. coa* as well as *N. bipennis* (Burmeister, 1839; Brauer, 1876; Hagen, 1886; McLachlan, 1886; Kirby, 1900; Kolbe, 1900; Navás, 1903, 1910, 1926; Lacroix, 1913; Auber, 1955), recently these old records have not or have been dubiously considered (Popov, 1970; Aspöck et al., 1980), now the french record is confirmed, and it is also recorded in Morocco, so a more West-Mediterranean, that only Iberian distribution must be assigned to this species.

Lertha sofiae Monserrat, 1988.

SPAIN: Almería, El Río Chico, 21. VII. 1991, 9 ♂♂ V. J. Monserrat, Rambla de Balanegra, 19. VII. 1988, 3 ♂♂, 1 ♀ V. J. Monserrat, 20. VII. 1991, 11 ♂♂, 5 ♀♀ V. J. Monserrat.

Nemoptera bipennis (Illiger, 1812).

FRANCE: Marseille, Mt. St. Pont, 1891, 1 ♂ A. David (MP). MOROCCO: Timadit, V. 1925, 1 ♀ Escalera (MCNM). PORTUGAL: Alfeite, Quinta do Brasileiro, VI–VII, 12 ♂♂ P. Mendoça. Campomaior, Embalse de Caya, 3. VI. 1990, 1 ♂, leg.? (UB). Caparica, 23. VI. 1969, 1 ♀ P. Mendoça. Corroios, Seixal, 6. VI. 1985 12 ♂♂, 4 ♀♀ J. dos Santos, 10. VI. 1985, 4 ♂♂, 4 ♀♀ A. Figueira. Riofrio, 14. VI. 1921, 1 ♀ Wattison (NHM). Setubal, VI. 1904, 1 ♂ L. Navás (MZB). Sines, 1. VI. 1970, 2 ♀♀ P. Mendoça. Tras os Montes, Villa Real, w.d., 1 ♀ McLachlan (NHM). Vilanova de Milfontes, 3. VII. 1971, 1 ♀ P. Mendoça, 9. VII. 1971, 1 ♀ P. Mendoça. SPAIN: Alicante, Aspe, VI. 1989, 11 ♂♂, 9 ♀♀ T. García, Biar, 24.–27. VI. 1963, 1 ♂ F. Español (MZB), Elche, VI. 1989, 12 ♂♂, 4 ♀♀ T. García. Almeria, Cabo de Gata, 20. VI. 1990, 1 ♂ V. J. Monserrat, San Juan, 30. VI. 1983, 2 ♀♀ V. J. Monserrat, Sierra Carbonera, 3. VI. 1911, 3 ♂♂, 1 ♀ J. Jacobs (NHM). Avila, Arenas de San Pedro, V.–VI. 1927, 5 ♂♂, 5 ♀♀ A. Schmidt (MCNM), Navaescorial, 16. VII. 1985, 1 ♀ F. Marín, Navalguijo, 27. VII. 1985, 2 ♀♀ J. L. Nieves, Parador de Gredos, 15. VII. 1930, 1 ♂, 2 ♀♀ L. Navás (MZB), 18. VII. 1930, 1 ♂ L. Navás (MZB), 18. VII. 1988, 1 ♂, 1 ♀ E. Clemente, Sierra de Gredos, La Cebedilla, 6. VII. 1985, 1 ♂ J. L. Viejo, Gredos, 18. VII. 1930, 1 ♂ L. Navás (MZB). Badajoz, Valle de Matamoros, 20. VI. 1985, 2. ♀♀ E. Clemente. Cáceres, Guadalupe, V. 1927, 1 ♂ M. Escalera (MCNM), Jarandilla de la Vera, 18. VI. 1990, 2 ♂♂ C. Ornosa, Plasencia, VI. 1919, 1 ♂ L. Navás (MZB). Cádiz, Almoraima, 23. V. 1911, 1 ♂ leg.? (NHM), Cádiz, w.d., 1 ♀ McLachlan (NHM), Gibraltar, w.d., 3 ♂♂, 2 ♀♀ Walker (NHM), La Línea, 28. V. 1911, 1 ♂ leg.? (NHM), 20. V. 1993, 4 ♂♂, 2 ♀♀ J. L. Torres, San Roque, 27. V. 1991, 2 ♀♀ J. Ramírez. Ciudad Real, Almadén, VI. 1950, 1 ♂ E. Morales (MCNM), Mestanza, VI. 1950, 1 ♂ E. Morales (MCNM), Puertollano, VI. 1950, 13 ♂♂, 20 ♀♀ E. Morales (MCNM), Villarta de San Juan, VI. 1932, 3 ♂♂, 3 ♀♀ E. Morales (MCNM). Cuenca, VI. 1953, 1 ♂ L. Higgins (NHM). Granada, Alfacar, 22. VI. 1927, 1 ♂, 1 ♀ B. H. Cooke (NHM), 19. VI. 1968, 1 ♂, 1 ♀ K. Sattler & D.J. Carter (NHM), Huéscar, 8. VI. 1896 1 ♂, 1 ♀ W. N. (NHM), Sierra Nevada, w.d., 1 ♂, 1 ♀ L. Bequest (NHM), Fuente Hervidero, La Zubia, VII. 1963, 2 ♀♀ F. Fernández Rubio (MCNM), 3. VII. 1989, 6 ♀♀ Duelli & Studer (CPD), Peñones de San Francisco, w.d., 4 ♂♂, 3 ♀♀ M. Baena, Valle del río Fardes, Diezma, 18. VI. 1968, 2 ♀♀ K. Sattler & D. J. Carter (NHM), 22. VI. 1968, 1 ♂ K. Sattler & D. J. Carter (NHM), Venta del Molinillo, 6. VII. 1989 5 ♀♀ Duelli (CPD). Huelva, Doñana, V–VI. 1957, 1 ♀ G. Mountfort (NHM). Jaén, Linares, VIII. 1934, 1 ♂ L. Navás (MZB). Lérida, Camarrasa, 3. VII. 1909, 2 ♂♂ L. Navás (MZB). Madrid, Aranjuez, VI. 1906, 1 ♂ Arias (MCNM), 23. VI. 1975, 2 ♀♀ V. J. Monserrat, 28. V. 1987, 1 ♂ V. J. Monserrat, Cenicientos, 11. VI. 1972, 1 ♂ R. Outerelo, Cercedilla, 28. VI. 1934, 2 ♀♀ L. Navás (MZB), 15.–26. VII. 1953, 1 ♀ H. Noack (MH), El Escorial, 29.–30. VII. 1879, 2 ♀♀ L. Bledse (NHM), 12. V. 1919, 1 ♂ L. Navás (NHM), 3. VII. 1934,

2 ♀♀ L. NAVÁS (MZB), El Pardo, w.d., 1 ♀ BOLIVAR (MCNM), Fuencarral, VI. 1945, 1 ♂ leg.? (MCNM), Galapagar, 18. VI. 1975, 1 ♂ V. J. Monserrat, Hoyo de Manzanares, 23. VI. 1980, 2 ♂♂, 2 ♀♀ V. J. Monserrat, 9. VI. 1990, 1 ♂, 5 ♀♀ V. J. Monserrat, 28. VI. 1992, 8 ♂♂, 6 ♀♀ V. J. Monserrat, 27. VI. 1993, 16 ♂♂, 16 ♀♀ V. J. Monserrat, 3. VII. 1993, 4 ♂♂, 7 ♀♀ V. J. Monserrat, La Cabrera, 28. VII. 1975, 1 ♀ V. J. Monserrat, Laguna de Ontígola, 25. V. 1982, 3 ♂♂, 3 ♀♀ V. J. Monserrat, La Pedriza, 19. V. 1934, 1 ♀ L. Navás (MZB), Madrid, 1908, 1 ♀ L. Navás (NHM), Miraflores de la Sierra, 16. VII. 1977, 1 ♀ J. Plaza, Montarco, VII, 1 ♂ L. Navás (NHM), 11. V. 1915, 1 ♂ L. Navás (MZB), 15. VI. 1924, 4 ♂♂, 16 ♀♀ L. Navás (MZB), 1 ♀ L. Navás (NHM), Navacerrada, VII. 1964, 1 ♀ F. Fernández Rubio (MCNM), Pelayos, 18. VI. 1992, 1 ♂, 1 ♀ R. Outerelo, Pinto, 9. VI. 1975, 4 ♂♂ V. J. Monserrat, Puerto de Navacerrada, w.d., 1 ♀ Zarco (MCNM), Ribas, VII. 1917, one slide with a just born larva, L. Navás (NHM), 21. VI. 1917, 2 ♀♀ L. Navás (MZB), Vaciamadrid, 18. VI. 1906, 1 ♀ Dusmet (MCNM), 9. VI. 1932, 1 ♀ L. Navás (MZB). Málaga, w.d., 1 ♀ leg.? (NHM), Ronda, Sierra de las Nieves, 1.100 m, V. 1993, 4 ♂♂, 4 ♀♀ J. L. Torres. Murcia, Abanilla, VI. 1934, 6 ♂♂, 3 ♀♀ Andreu (MCNM), Aguilas, w.d., 1 ♀ G. I. Boag (NHM), spring 1896, 1 ♀ Rothschild (NHM), Los Puertos, 12. VI. 1982 1 ♀ V. J. Monserrat, 24. VI. 1982 6 ♀♀ V. J. Monserrat, Mazarrón, 24. VI. 1982 2 ♀♀ V. J. Monserrat, Murcia, 1918, 1 ♀ L. Navás (MZB), VI. 1923, 1 ♂ G. I. Boag (NHM), Sierra Espuña, V. 1927, 2. ♀♀ F. Escalera (MCNM). Salamanca, Béjar, VI–VII. 1902, 2 ♂, 1 ♀ T.A.C. (NHM), Mogarraz, w.d., 1 ♂ J. Abajo (MCNM). Segovia, San Rafael, 1927, 3 ♀♀ I. Bolívar (MCNM). Sevilla, VII. 1907, 1 ♀ L. Navás (MZB). Teruel, Albarracín, 12. VII. 1904, 1 ♀ L. Navás (MZB), VII. 1906, 1 ♀ Arias (MCNM). Zaragoza, Pina de Ebro, 26. V. 1990 12 ♂♂, 3 ♀♀ J. Blasco.

5. Systematic considerations

Systematics and phylogenetic relationships among different families of Neuroptera on the basis of larval characters have many times been forgotten, and most of the classic general classifications are mainly based on imagoes characters. From Withycombe (1925) larval morphology, as a crucial point, starts its modern phylogenetic classification, and larval morphology has recently induced very interesting new arguments, discussions and hypothesis (Popov, 1973; Henry, 1978; New, 1989; Brooks & Barnard, 1990; Mansell, 1992; Aspöck, 1992, 1993; Aspöck et al., 1980), but systematics and relationship within the Neuroptera, are by no means clear at all (Tauber & Adam, 1990; Aspöck, 1992, 1993).

Without coming into a general discussions, and circumscribing to Nemopteridae, its systematic position, as a natural family, is mainly based on the presence of long hindwings and specialized mouthparts for pollen and nectar collection, being considered as a monophyletic group close to Myrmeleontidae, Ascalaphidae and Nymphidae (Hölzel, 1975; Henry, 1978; Mansell, 1986, 1992). After to know better some morphological characters of Nemopterinae larvae, it is evident, that the "close relationships" between Crocinae and Nemopterinae seem to be no more than artificial. The presence – absence of oviruptor, kind of egg-rupture and aeropyles on egg, as much as some differencial larval characters as: two segmented – multisegmented antenna, absence – presence of inner mandibular teeth, four – three segmented labial palp, 0 to 7 – 6 to 8 stemmata, prothorax normal or specialized and sclerotized, legs short and digger – long and walker, with fore leg tibia fussed to tarsus – independent to tarsus, with – without lateral thoracic and abdominal tubercles, presence – absence of chitinized structures in hind ventral 7th abdominal segment, as much as known differences on larval biology and behaviour, can no longer sustain the actually considered Nemopteridae as a natural and monophyletic taxa, many other well established and defined families in Neuroptera have less, and less important differences among their larvae than between Nemopterinae and Crocinae. The two unique argued characters as the specialized mouthparts of nectar and pollen nutrition was considered as plesiomorphic character (Brooks & Barnard, 1990) and it is present in other

families (New, 1989; Mansell, 1992), and the presence of hindwings has also evident functional and morphological differences (broad apical dilation – filamentous tip, presence – absence of Media vein, presence – absence of pterostigma and frequent and diverse differenciated wing setation and structures do not existing in Nemopterinae are present in Crocinae). The presence of long hindwings has not an enough phylogenetic weight, by the same character would be unthinkable to reunite the all normal-winged neuroptera into one "natural" family. So, both subfamilies, (erected by Navás (1910) with tribe category) Nemopterinae and Crocinae, must be considered with family rank, fact some time suggested, recently by Popov (1973). The description of family Nemopteridae, in Burmeister (1839) sense, has a mixed (Crocinae + Nemopterinae) conception, a wrong original nomination (as Nematopteridae, that it is an incorrect an unjustified emendation of original latinization of *Nemoptera* Latreille, 1802) and genus *Nematoptera* as type genus by monotypy. By priority law, the family name Nemopteridae of Burmeister (1839) remains, but its concept must be restricted to the Nemopterini (in sense of Navás (1910) tribe designation), adding their larval characters now exposed. The subfamily Crocinae (in sense of Navás (1910) tribe designation) must be erected with a family status, with the same concept, but adding their larval characters now exposed. So two different families must be considered:

Nemopteridae Burmeister, 1839 = (Nematopteridae Burmeister, 1839 *partim*).

Type genus: **Nemoptera** Latreille, 1802.

Crocidae Navás, 1910 = (Nematopteridae Burmeister, 1839 *partim*), **stat. n.**

Type genus: **Croce** McLachlan, 1885.

The systematic position within the Neuroptera of these, now separately considered families, must be commented. Usually the mixed characters of Crocinae and Nemopterinae all told, have caused problems in the systematic position and relationship of the previous concept yet of the Nemopteridae family, as well as their two subfamilies (Hölzel, 1975; Mansell, 1986, 1992). Under our point of view, Crocidae, in its new family status, must remain behind, but inside of the same Mansell's (1992) cluster, with Myrmeleontidae, Ascalaphidae and Nymphidae, because the apomorphic traits 10 & 11 (long hindwings, specialized mouthparts) gived in Mansell's (1992) cladogram, have been questioned and trait 15 (developed larval inner mandibular teeth) cannot exclude to Crocidae, because its presence is evident in genera *Josandreva, Pterocroce, Austrocroce,* and *Carnaviana,* existing (and recorded as inner papillae) in other genera as *Laurhervasia, Thysanocroce, Concroce* and *Tjederia* (Monserrat, 1983a, b; Mansell, 1980, 1981a, b, 1983b). On the other hand, some characters of Nemopteridae, in the proposed status, as the presence of oviruptor, lateral tubercles bearing setae and the myrmecophily in the larvae, must be added, as other new arguments, to those exposed by Mansell (1992) when discuss the close the relationship between Nemopteridae and Chrysopidae, long suggested (Navás, 1910). Also the character 5 (multisegmented flagellum of larvae) of Aspöcks (1992) cladogram, would exclude Nemopteridae (in the proposed status) from Myrmeleontiformia where it was included, to Hemerobiiformia where Chrysopidae is included.

However, the systematic position of the Nemopteridae (in the proposed status) and its relationship with other families is still not full clear, and new evidences and new larval studies would be necessary to clarify this or any other hypothesis.

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References

Aspöck, H., Aspöck, U. & Hölzel, H. (1980): Die Neuropteren Europas. 1, 495 pp., 2, 355 pp., Goecke & Evers Krefeld.

Aspöck, U. (1992): Crucial points in the phylogeny of the Neuroptera (Insecta). *In* Current research in Neuropterology. *Proceedings Forth Int. Symp. on Neuropterology.* Canard, M., Aspöck, H., Mansell, M. W. (*eds.*), p. 63–73, Toulouse.

– (1993): Geklärtes und ungeklärtes im System der Neuroptera (Insecta: Holometabola). *Mitteilungen der Deutschen Gesellschaft für Allgemeine und Angewandte Entomologie* **8**: 451–456.

Auber, J. (1955): Au sujet du Némoptère de France (Planip.). *Bulletin de la Societé Entomologique de France* **60**: 170–173.

Blair, K. G. (1921): Note. *Proceedings of the South London Entomological and Natural History Society* **1921**: 85.

Brauer, F. (1876): Die Neuropteren Europas und insbesondere Österreichs mit Rücksicht auf ihre geographische Verbreitung. *Festschrift zur 25jährigen Feier der zoologisch botanischen Gesellschaft* Wien: 263–300.

Brooks, S. J. & Barnard, P. C. (1990): The green lacewings of the world: a generic review (Neuroptera: Chrysopidae). *Bulletin of the British Museum (Entomology)* **59** (2): 117–286.

Brulle, A. (1832): Insecta. *In* Expedition Scientifique de Morée. Sect. des Sci. Phys., t. III *Zool. et Botanique:* 64–395. *Neuropteres:* 275–278.

Burmeister, H. C. C. (1839): Handbuch der Entomologie. *Neuroptera:* 757–1050. pl. I–XII, Berlin.

Dufour, L. (1857): Fragments d'anatomie entomologique I. Sur l'appareil digestif et les ovaires du Neuroptera lusitanica. *Annales des Sciences Naturelles* **4** (VIII): 5–10, pl. 1.

Friedrich, H. (1953): Neuroptera. *In* Bronns Klassen und Ordnungen des Tierreichs. 5 Bd, *Arthropoda* 3. Abt., *Insecta* 12 Buch, Teil a, 148 pp. Akademische Verlagsgesellschaft Geest & Portig. Leipzig.

Gerson, U. & Smiley, R. L. (1990): Acarine biocontrol agents. An illustrated key and manual. Chapman & Hall, 174 pp. London.

Hagen, H. A. (1866): Die Neuropteren Spaniens nach Ed. Pictet's Synopsis des Néuroptères d'Espagne. Geneve 1865, 8. tab. 14. col. und Dr. Staudingers Mittheilungen. *Stettiner Entomologische Zeitung* **27**: 281–302.

– (1886): Monograph of the Hemerobiidae. Part. I. Nemopteridae. *Proceedings of the Boston Society of Natural History* **23**: 250–269.

Hagley, E. A. & Miles, N. (1987): Release of *C. carnea* Stephens (Neuroptera: Chrysopidae) for Control of Tetranychus urticae Kock (Acarina: Tetranychidae) on peach grow in a protected environment structure. *Canadian Entomologist* **119** (2): 205–207.

Hartzell, A. (1918): A Chigger Mite of *Chrysopa* Larvae. *Journal of Economic Entomology* **11**: 386.

Henry, C. S. (1978): An unusual ascalaphid larva (Neuroptera: Ascalaphidae) from Southern Africa, with comments on larval evolution within the Myrmeleontoidea. *Psyche* **85** (2): 265–274.

Hölldobler, B. & Wilson, E. O. (1990): The ants. Belknap Press, Cambridge, 732 pp.

Hölzel, H. (1975): Revision der Netzflügler-Unterfamilie Crocinae (Neuroptera: Nemopteridae). *Entomologica Germanica* **2** (1): 44–97.

Hughes, A. M. (1976): The mites of stored food and houses. *Ministry of Agriculture, Fisheries and Food, Technical Bulletin* 9, 400 pp., London.

Kiesenwetter, H. V. (1857): Physiognomische Betrachtung einiger Insektenformen. *Berliner Entomologische Zeitschrift* **1**: 60–69.

Killington, F. J. (1936): A monograph of the British Neuroptera. *Ray Society,* Vol. I, 269 pp., 15 pl., London.

Kirby, W. F. (1900): Notes on Neuropterous family Nemopteridae. *Annals and Magazine of Natural History* **7** (6): 456–464.

Kis, B., Nagler, C. & Mandru, C. (1970): Neuroptera (Planipennia). *Fauna Republicii Socialiste Romania,* Buçuresti, **8** (6): 1–343.

Kolbe, H. J. (1900): Über die Arten der eigenthümlichen Nemoptere. *Sitzungsberichte der Gesellschaft der Naturforschenden Freunde Berlin* **1900**: 10–18.

Lacroix, J. L. (1913): Contribution à létude des Névrotères de France. *Feuille jeunes naturalistes* **43**: 98–103.

Mansell, M. W. (1973): The first record of a larval nemopterid from southern Africa (Neuroptera: Nemopteridae: Nemopterinae). *Journal of the Entomological Society of South Africa* **1**: 133–137.

– (1976): The larva of *Laurhervasia setacea* (Klug), (Neuroptera: Nemopteridae: Crocinae) from southern Africa. *Journal of the Entomological Society of South Africa* **39** (2): 153–158.

– (1977): A new genus and species in the Crocinae (Neuroptera: Nemopteridae) from Southern Africa. *Journal of the Entomological Society of South Africa* **40** (2): 195–203.

– (1980): The Crocinae of southern Africa (Neuroptera: Nemopteridae), 1. The genera *Laurhervasia* Navás and *Thysanocroce* Withycombe. *Journal of the Entomological Society of South Africa* **43** (2): 341–365.

– (1981a): The Crocinae of southern Africa (Neuroptera: Nemopteridae). 2. The genus *Concroce* Tjeder. *Journal of the Entomological Society of South Africa* **44** (1): 91–106.

– (1981b): The Crocinae of southern Africa (Neuroptera: Nemopteridae). 3. The genus *Tjederia* Mansell, with keys to the southern African Crocinae. *Journal of the Entomological Society of South Africa* **44** (2): 245–257.

– (1983a): New Crocinae (Neuroptera: Nemopteridae) from South America, with descriptions of larvae. *Journal of the Entomological Society of South Africa* **46** (1): 115–130.

– (1983b): A Revision of the Australian Crocinae (Neuroptera: Nemopteridae). *Australian Journal of Zoology* **31**: 607–627.

– (1986): Biogeography and Phylogeny of the Crocinae (Neuroptera: Nemopteridae). *In* Gepp, J., Aspöck, H. & Hölzel, H. (*eds.*) *Recent Research in Neuropterology,* Graz: 77–84.

– (1992): The systematic position of Nemopteridae (Insecta: Neuroptera: Myrmeontoidea). *In* Current research in Neuropterology. *Proceedings Forth Int. Symp. on Neuropterology.* Canard, M., Aspöck, H. & Mansell, M. W. (eds.), p. 63–73, Toulouse.

Mathews, W. H. (1947): Some notes on the spoon-winged lacewings *(Chasmoptera hutti). Western Australian Naturalist* **1**: 42–44.

McLachlan, R. (1886): Note concerning certain Nemopteridae. *Proceedings of the Entomological Society London* **1886**: 57–58.

Monserrat, V. J. (1977): Los Neurópteros del Guadarrama. *Trabajos Cátedra de Artrópodos, Facultad de Biología Universidad Complutense Madrid* **19**: 1–202.

– (1983a): Estadios larvarios de los neurópteros ibéricos I.: *Josandreva sazi.* (Neur., Plan. Nemopteridae). *Speleon* **26–27**: 39–51.

– (1983b): *Pterocroce capillaris* (Klug, 1836) en Europa (Neur., Plan., Nemopteridae). *Neuroptera International* **2, 3**: 109–128.

– (1985): Morfología del huevo en los Nemoptéridos Ibéricos. (Neur., Plan., Nemopteridae). *Actas II Congr. Ibér. Entomol. Lisboa* t.**II**: 463–474.

– (1988): Revisión de las especies de Lertha del Mediterráneo occidental. (Neuropteroidea: Planipennia: Nemopteridae). *Annali del Museo Civico di Storia Naturale Giacomo Doria* **87**: 85–113.

– & Martínez, M. D. (1995): On the Possible Myrmecophily of Nemopterinae (Neuroptera, Nemopteridae). *Sociobiology* **26**: 1, 55–68.

Navás, L. (1903): Neuropteros prostomios de la Peninsula Ibérica. *Broteria* **2**: 107–113, pl. 1.

– (1910): Monografia de los Nemopteridos (Insectos Neurópteros). *Memorias de la Real Academia de Ciencias y Artes de Barcelona* **8**: 339–408.

– (1924a): Comunicaciones. *Boletin de la Sociedad Ibérica de Ciencias Naturales* **23, 6, 6–7**: 65–67.

– (1924b): Sinopsis de los Neurópteros (Ins.) de la Peninsula Ibérica. *Memorias de la Sociedad Ibérica de Ciencias Naturales* **4**: 1–150.

– (1924c): Entomologia de Catalunya. Neurópters. Fasc. I. Neurópters propis. Fauna de Catalunya. *Publicationes de L'Institut de Estudis Catalans, sec. cien.* (1923), 271 pp., Barcelona.

– (1926): Les Némoptérides (Ins. Névroptères) du Muséum National de Paris. *Bulletin du Muséum d'Histoire Naturelle Paris* **32, 1920**: 138–139.

New, T. R. (1989): Planipennia, Lacewings. Handbuch der Zoologie IV, 30, 132 pp. Walter de Gruyter. Berlin.

Owen Evans, E., Sheals, J. G. & Macfarlane, D. (1961): The terrestrial acari of British Isles. An Introduction to their Morphology, Biology and Classification. *Trustees of the British Museum,* vol. 1, 219 pp. Oxford.

Pantaleoni, R. A. (1983): Note su alcuni parassiti (s.l.) di Neurotteri Planipenni con segnalazione del ritrovamento di Acari foretici su di un Crisopide. *Bollettino dell'Instituto di Entomologia* "Guido Grandi" della Universita degli Studi di Bologna **38**: 139–203.

Parfin, S. I. & Gurney, A. B. (1956): The spongilla-flies references to those of the western hemisphere (Sisyridae, Neuroptera). *Proceedings of the United States National Museum* **105, 3360**: 421–529, pl. 1–3.

Picker, M. D. (1984): A new genus and species of spoon-wing lacewing (Neuroptera: Nemopteridae) from Namaqualand, South Africa. *Journal of the Entomological Society of South Africa* **47** (2): 259–268.

– (1987): An unusual species of spoon-wing lacewing (Neuroptera: Nemopteridae) from South Africa, with notes on its biology. *Systematic Entomology* **12**: 239–248.

– **Leon, B. & Londt, J. G. H.** (1991): The hypertrophied hindwings of *Palmipenna aeoloptera* Picker, 1987 (Neuroptera: Nemopteridae) reduce attack by robber flies increasing apparent body size. *Animal Behavior* **42**: 821–825.

– (1992): Influence of hindwing size in nemopterids (Insecta: Neuroptera: Nemopteridae) on predation by robber flies (Diptera: Asilidae). In: Current research in Neuropterology. *Proceedings Forth Int. Symp. on Neuropterology.* Canard, M., Aspöck, H. & Mansell, M. W. (eds.), p. 313–318, Toulouse.

Popov, A. (1963): Edno interesno mrezhokrilo nasekomo v Bulgariya Nemoptera sinuata. *Priroda* **12** (3): 90–93.

– (1970): Verbreitung der europäischen Nemopteriden-Arten (Neuroptera). *Bulletin de l'Institut de Zoologie et Musée* **32**: 5–31.

– (1973): Über die präimaginalen Stadien paläarktischer Vertreter der Ordnung Neuroptera und der Versuch einer neuen systematischen Gruppierung der Familien mit Rücksicht auf ihre morphologischen und ökologischen Besonderheiten. *Bulletin de l'Institut de Zoologie et Musée* **37**: 79–101.

Principi, M. M. (1956): Contributo allo studio dei Neurotteri italiani. – XIII. Studio morfologico, etologico e sistematico di un gruppo omogeneo di specie del genero *Chrysopa* Leach (*C. flavifrons* Brauer, *prasina* Burm.e *clathrata* Schn.). *Bollettino dell'Instituto e Museo di Entomologia della Università degli Studi di Bologna* **21**: 319–410.

Rosenhauer, W. G. (1856): Die Thiere Andalusiens nach dem Resultate einer Reise. Verlag von T. Blaesing, Erlangen, 429 pp.

Saz, E. (1925): La *Josandreva sazi* Nav. *Iberica* **1925**: 67–70.

Schaum, H. (1857): *Necrophilus aernarius* Roux die muthmassliche Larve von Nemoptera. *Bericht. Entomologische Zeitschrift* **1**: 1–9, pl.

Smith, R. C. (1922): The biology of the Chrysopidae. *Memoirs Cornell University, Agricultural Experiment Station* **58**: 1287–1372, pl. 85–8.

Tauber, C. A. & Adams, P. A. (1990): Systematics of the Neuropteroidea: present status and future needs. *In* **Kosztarab, M. & Schaefer, C. W.** (eds.) Systematics of the North American Insects and Arachnids: Status and needs. *Virginia Agricultural Experiment Station Information,* Ser.: 90–91, Blacksburg.

Tjeder, B. (1967): Neuroptera-Planipennia of Southern Africa. Nemopteridae. *South African Animal Life* **13**: 290–501.

Tröger, E. J. (1993): Die Larve von *Nemoptera coa* (Linnaeus, 1758) (Neuropteroidea, Planipennia). *Deutsche Entomologische Zeitschrift,* N.F. **40** (2): 357–368.

Wheeler, W. M. (1929): Is *Necrophilus arenarius* Roux the larva of *Pterocroce storeyi* Withycombe. *Psyche* **36**: 313–320.

Withycombe, C. L. (1925): Some Aspects of the Biology and Morphology of the Neuroptera. With special reference to the immature stages and their possible phylogenetic significance. *Transactions of the Entomological Society of London* **1924**: 303–411.

Bibliography of the Neuropterida

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