

SPECIES OF THE GENUS *PUFFINOECUS* EICHLER, 1949 (MALLOPHAGA: PHILOPTERIDAE) PARASITES ON SHEARWATERS (AVES: PROCELLARIIDAE)

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ABSTRACT: The Phthiraptera species of the genus *Puffinoecus* are reviewed, and a redescription of the genus is made. Keys to determine the studied species are given and new reliable taxonomic characters which complete the original descriptions of the species are stated. A new synonymy is established for *Puffinoecus nadleri* as a synonym of *P. puellula*.

KEY WORDS: Mallophaga, *Puffinoecus* spp., taxonomy, hosts, *Puffinus* spp., shearwaters.

INTRODUCTION

EICHLER (1949) established the genus *Puffinoecus* for a group of species of *Saemundssonina* Timmermann that are parasitic on shearwaters (*Puffinus* s.l.). The genus was characterized by a markedly slender forehead, concavo-lateral, with the clypeus projecting forwards, bill shaped and oculus sexually dimorphic. As type species he described the species *P. peusi* on *Puffinus diomedea* (Scopoli) and included within the genus the following species: *P. enderleini* (Eichler) on *Pterodroma mollis* (Gould), *P. bicolor* (Rudow), *P. coloratus* (Rudow), *P. gaini* (Neumann) and *P. minor* (Kellogg et Kuwana). This genus has not been recognized by subsequent authors.

HOPKINS & CLAY (1952) considered *Puffinoecus* not separable from *Saemundssonina*. They cite within their check-list several other species on shearwaters: *S. minor* on *Puffinus lherminieri subalaris* Ridgway, *S. orientalis* (Uchida) on *P. leucomelas* (Temminck), *S. peusi* (Eichler) on *Puffinus diomedea* (Scopoli) and *S. valida* (Kellogg et Chapman) on *P. opisthomelas* (Coues). All these species belong to *Puffinoecus*.

Similarly, TIMMERMANN (1962) did not agree with the validity of *Puffinoecus*, although he made reference to the clear characterization of the species given by EICHLER for the peculiarity of the structure of its forehead. He made a brief descriptive revision of the *Saemundssonina* species quoted by HOPKINS & CLAY (1952), in addition to the species that EICHLER (1949) included within *Puffinoecus*, concluding that, of these, only *minor* belongs to the «*Puffinoecus* group». In the same paper TIMMERMANN (1962) described three new parasite species on shearwaters: *S. kosswigi* on *Puffinus p. yelkouan* (Acerbi), *S. persica* on *P. lherminieri persicus* (Hume) and *S. jamaicensis* on *Pterodroma caribbaea* (Carte). Subsequently the same author (TIMMERMANN, 1965), in a paper about *Saemundssonina* on Procellariiformes, set out several species groups, including the «*Puffinoecus* group». He pointed out that «the establishment of the genus *Puffinoecus* by EICHLER is based

on a very characteristic morphological type, although not significant enough that it makes necessary or even desirable the generic separation of these species». TIMMERMANN (loc. cit.) gave some morphological data for the known species of the «*Puffinoecus* group» and described one new species, *S. puellula* on *Puffinus pacificus cuneatus* Salvin. In a later work, TIMMERMANN (1972) indicated that «because of its long and narrow clypeus and the typical tree or cactus-like sclerotisations of the male genitalia, the *Saemundssonina* species, parasites on Procellariidae, must be given the rank of subgenus».

EMERSON (1972) cited five species of *Saemundssonina* found on birds of the genus *Puffinus*, considering *Puffinoecus* a synonym of *Saemundssonina*. ZLOTORZYCKA (1978) accepted the genus *Puffinoecus* as separate from *Saemundssonina*, though she based her distinction on a not very consistent feature. In addition she added two species, *P. incisus* (Timm.) and *P. thalassidromae* (Denny), clearly different from those which form part of the genus created by EICHLER. LEDGER (1980) included among the *Saemundssonina* parasitic on Procellariiformes, belonging to the «*Puffinoecus* group» the following species: *S. kosswigi*, *S. peusi*, *S. persica*, *S. minor*, and *S. puellula*, though considering *S. persica* as young synonym of *S. minor*. MEY (1989) stated that «*Puffinoecus*» is without any doubt a closely related group to *Saemundssonina*, but the forehead and the male genitalia configuration allow definite separation of *Puffinoecus* from *Saemundssonina* and justified its valid generic status.

The purpose of this paper is: a) to provide a clear characterization of the genus *Puffinoecus*; b) to provide a key for the identification of *Puffinoecus* species; c) to add new taxonomic data to the present brief and scarce descriptions of these species.

MATERIAL AND METHODS

The specimens studied are deposited in The Natural History Museum, London (N.H.M.), the Museo Nacional de Ciencias Na-

torales, Madrid (M.N.C.N.), and the Naturhistorisches Museum Rudolstadt (N.H.R.). The *Saemundssonina* species used for the comparison [*S. integer* (Nitzsch) on *Grus grus* (L.); *S. mülleri* Eichler on *Larus ridibundus* L., and *S. upoluensis* (Rudow) on *Phaeton lepturus* Mathews] are kept in the Entomology Collection of the M.N.C.N. of Madrid.

Data on *P. validus* (Kellogg et Chapman) and *P. enderleini* Eichler have been taken from literature, as well as the data of *Saemundssonina* species on Procellariiformes included in the groups related to *Puffinoecus*.

The taxonomic analysis was done using slides of microscopic material, mounted in Canada Balsam (N.H.M.) or Hoyer's Liquid (M.N.C.N.). The terminology used related to the sclerotised structures and the chaetotaxy follows CLAY (1951).

The measurements of the specimens were carried out by means of a WILD MMS-231 stereoscopic digital micrometer and are given in millimeters. The abbreviations are the following: T.L. = total length of the body measured along its mid-line from the apex of the clypeus margin; A.B. = maximum breadth of abdomen; H.L. = head length, taken from the apical extreme of the clypeus margin; H.B. = maximum breadth at the level of the temples; P.L. = paramere length; M.B. = mesosome breadth. Because of the stiffness of the head structure its measurements, especially the breadth at the temples, remain constant under different treatments in mounting, and for this reason these measurements can be of great help in specific differentiation. Nevertheless, the most useful criterion is the C.I. (cephalic index, ratio H.B./H.L.), since the proportions of the breadth and the length of the head are relatively uniform.

The drawings are original and were made with the aid of a camera lucida attached to a Leitz Diaplan microscope, except for these specimens taken from literature.

Genus *Puffinoecus* Eichler, 1949

Diagnosis

Original description: *Boll. Soc. Ent. Ital.*, 79: 12. Type species: *Puffinoecus peusi* Eichler, 1949.

Characterization: Anterior region of the head strongly narrowed and extended forward, margins slightly concave, at the end almost parallel, projecting markedly from the anterior margin of the head. Frontal hyaline margin deeply concave, forming a more or less distinctive ocellum. Frontal margin of clypeal plate appears notched in parallel to the hyaline margin. Male genitalia with typical warty sclerotisations, cactus or tree-like, located between the heads of the parameres, towards the posterior region of the basal plate.

Description

Male: Triangular head widened at the level of the temples. Subpentagonal clypeal plate; the rounded posterior margin is prolonged with a sclerotised point projected as a conoidal appendix, inserted through the preantennal suture behind the mandibles (Fig. 1 A-L). Mandibles stout and strongly sclerotised. Lateral marginal carinae extending further than the end of the clypeal plate. Distinct preantennal and postantennal sutures. Temporal carinae narrow, the occipital ones slightly sclerotised. Filiform antennae (similar in both sexes).

First segment broadened, second long and the three following subequal in length. Large conus, with a blunt point which exceeds the first antennal segment.

Chaetotaxy: dorsally (at each side): 1 submarginal seta, 1 anterior, 1 preantennal, 1 postnotal, 1 ocular, 2 long temporal. Ventrally: 2 submarginal, 3 anterior, 1 preconal, 1 temporal, spiniform.

Thorax: prothorax trapezoidic with a median seta in each postero-lateral angle. Pterothorax with convergent edges, blunt postero-lateral angles with one long seta and one spine on its lateral apex; posterior margin round, with a variable number of setae depending on the species.

Abdomen oval, widened. Elongated triangular tergo-pleural plates, widely separated at the mid-part in segments II-IV, fused in V-VII; VIII with two triangular plates separated in the middle; IX with a single plate and X with two small plates. The segments bearing spiracles are from III (2nd apparent) to VIII. Narrow pleural plates, heavily chitinized, exceeding each other at the former segment. Segments II-III without sternal plates; IV-VI with central and curved plates; VII-VIII sternal plates make up the subgenital plate. The abdominal chaetotaxy varies slightly, depending on the species. (Fig. 6 A-F).

Male genitalia with broad basal plate, whose lateral edges are articulated with the heads of the parameres. These are inwardly curved and internally joined with the endomeres; between them is situated the hypomere from which the penis is projected with or without telomeres at its sides. The tree or cactus-like sclerotisations of the genital sac are found between the heads of the parameres, and reach the inferior zone of the basal plate. All the structures of the male genitalia are specifically variable in form and shape, so they are of a great taxonomic value.

Female: Similar to the male, but generally with the head and the abdomen wider. The sexual dimorphism of the ocellum, mentioned by EICHLER (1949), is not very distinct, and so has not been considered by different authors. Nevertheless, a careful study of it has proved that there are slight variations of this structure related to sex.

In contrast to the male, the tergal plates of the abdomen of the female are triangular and shorter, without reaching the middle part of the abdomen, excepting the second last (morphologically IX), in which they are fused in a large plate that occupies the whole segment. Pleural plates similar to the male and the sternal ones absent in segments II-IV; segments VII-VIII with sternal plates joined, forming the genital plate; finally the second last segment is made up of two plates with insignificant variations in its shape in the different species of the genus.

The abdominal chaetotaxy of females also varies depending on the species, but the first segments always have an area without setae.

Remarks

The taxonomic study of eight of the ten described species of the group shows that the characters which define

the genus are constant in all of them, both in males and females (Fig. 1 A-L). The typical shape of the forehead distinguishes them from related species of *Saemundssonina* that are parasitic on Procellariiformes (Fig. 2 A-C): *S. desolata* Tim. (*thalassidromae* group), *S. occidentalis* (Kellogg) and *S. gaini* (Neumann). Moreover, this difference has been checked against parasite species of other avian groups (Fig. 2 D-F): *S. upoluensis* (Rudow) on Pelecaniformes; *S. muelleri* Eichler on Charadriiformes, and *S. integer* (Nitzsch) on Gruiformes.

The presence of warty sclerotisations in the male genitalia is in common with other species parasitic on Procellariiformes: *S. incisa* Tim., *S. desolata* Tim. (*thalassidromae* group); *S. occidentalis* (Kellogg); *S. nivea* Tim., *S. stammeri* Tim. (*occidentalis* group), but those never have the tree or cactus-like appearance of these sclerites in the male genitalia of the species of *Puffinoecus*. This structure is lacking in some other of the *Saemundssonina* species.

For all the aforementioned reasons (the typical shape of the forehead and the tree or cactus-like appearance of the warty sclerotisations of the male genitalia), I have accepted the «*Puffinoecus* group» with an independent generic status.

Keys

The *Puffinoecus* species are morphologically very homogenous, especially the females, in which specific variations are so weak that they cannot be used for its differentiation. The key has been based on the male genitalia since only these give reliable taxonomic characters.

1. Penis with two telomeres 2
– Penis without telomeres 6
2. Parameres with long head; peg-shaped inner endomeral projections (Fig. 3G, 4G, 5G)
..... *puellulus* (=nadleri)
– Parameres with normal head; inner endomeral projections more or less marked 3
3. Parameres long, third inferior part of the outer margin curved followed by a narrowing near the apex; endomeres with feeble endomeral projections, not joined in the middle (Fig. 3D, 4D, 5D) *jamaicensis*
– Parameres shorter, outer margin straight; endomeres with well-marked endomeral projections, joined in the middle forming a bridge 4
4. Parameres with curved inner margins (Fig. 3B, 4B,) *minor*
– Parameres with straight inner margins 5
5. Peg-shaped inner endomeral projections with very sharp inferior angles; penis long, extending well beyond the telomeres (Fig. 3C, 5C) *orientalis*
– Inner endomeral projections with less marked inferior angles, penis not extending beyond the telomeres (Fig. 3A, 5A) *peusi*
6. Short and stout parameres, without narrowing at the

- proximal part of the head; short penis hardly beyond the endomeres (Fig. 3E, 4E) *kosswigi*
– Thinner parameres, narrowing at the proximal part of the head; long penis well beyond the endomeres (Fig. 3F, 4F) *persicus*

Puffinoecus jamaicensis (Timmermann, 1961)

References: *Saemundssonina jamaicensis* Timmermann, 1962: 430-431 (TIMMERMAN, 1965: 80). *Puffinoecus jamaicensis* (Timmermann) (MEY, 1989: 51).

Material: Holotype: 1 male on *Pterodroma caribbaea* Carte, Jamaica. Coll. Meinertzhagen Slide 12483. (N.H.M.) (examined).

Material examined: 1 male, holotype on *Pterodroma caribbaea* Corte, Jamaica (N.H.M.).

Figures: 1C, 3D, 4D, 5D, 6A.

Measurements: of 1 specimen male (type): TL = 1,79; AB = 0,84; HL = 0,70; TB = 0,68; CI = 0,97; PL = 0,34; MB = 0,20.

Male: Head large, clypeal plate narrow and long, its anterior edge deeply concave and its posterior extension quite long (Fig. 1C); stout conoidal projection of the plate running across the postantennal suture not reaching mandibles.

Thorax and abdomen as in generic description. Metasutural plate oval, with irregular edges and two long, central setae. Posterior margin of pterothorax with 13 setae. Abdominal chaetotaxy: tergal setae: II, 1+1; III, 3+3; IV, 4+3; V, 3+3; VI, 2+3; VII, 2+2; VIII, 2+2; pleural setae (at each side) II, 0; III, 1; IV-VII, 3; VIII, 2; sternal setae: III, 2 (minute); IV, 2 (minute) and 2+1 medium; V-VII, 2+2; VIII, 1+1. Postspiracular setae on segments IV-VIII. Number and arrangement of setae on the terminal segments as in Fig. 6A (a and b).

Genitalia large (Fig. 3D), lateral arms of basal plate with parallel edges; parameres stout with rounded, thick head narrowed proximally, inner margins almost straight, outer margins straight in basal two-thirds, apical third with an extended convexity that narrows at the apical zone (Fig. 4D). Inner endomeral projections slightly extended, unfused (Fig. 3D). Hypomere long, with two stiletto-like telomeres, penis relatively short. The warty sclerotisations are tree-like.

Female: unknown.

Puffinoecus kosswigi (Timmermann, 1962)

References: *Saemundssonina kosswigi* Timmermann, 1962: 427 (TIMMERMAN, 1965: 78; EMERSON, 1972: 157; ZLOTORZYCKA, 1978: 49; LEDGER, 1980: 135). *Puffinoecus kosswigi* (Timmermann) (MEY, 1989: 50).

Material: Holotype male and allotype female on *Puffinus puffinus yelkouan* (Acerbi). Aegaeon Sea. June 1935. Coll. Meinertzhagen Slide. 3781. (N.H.M.).

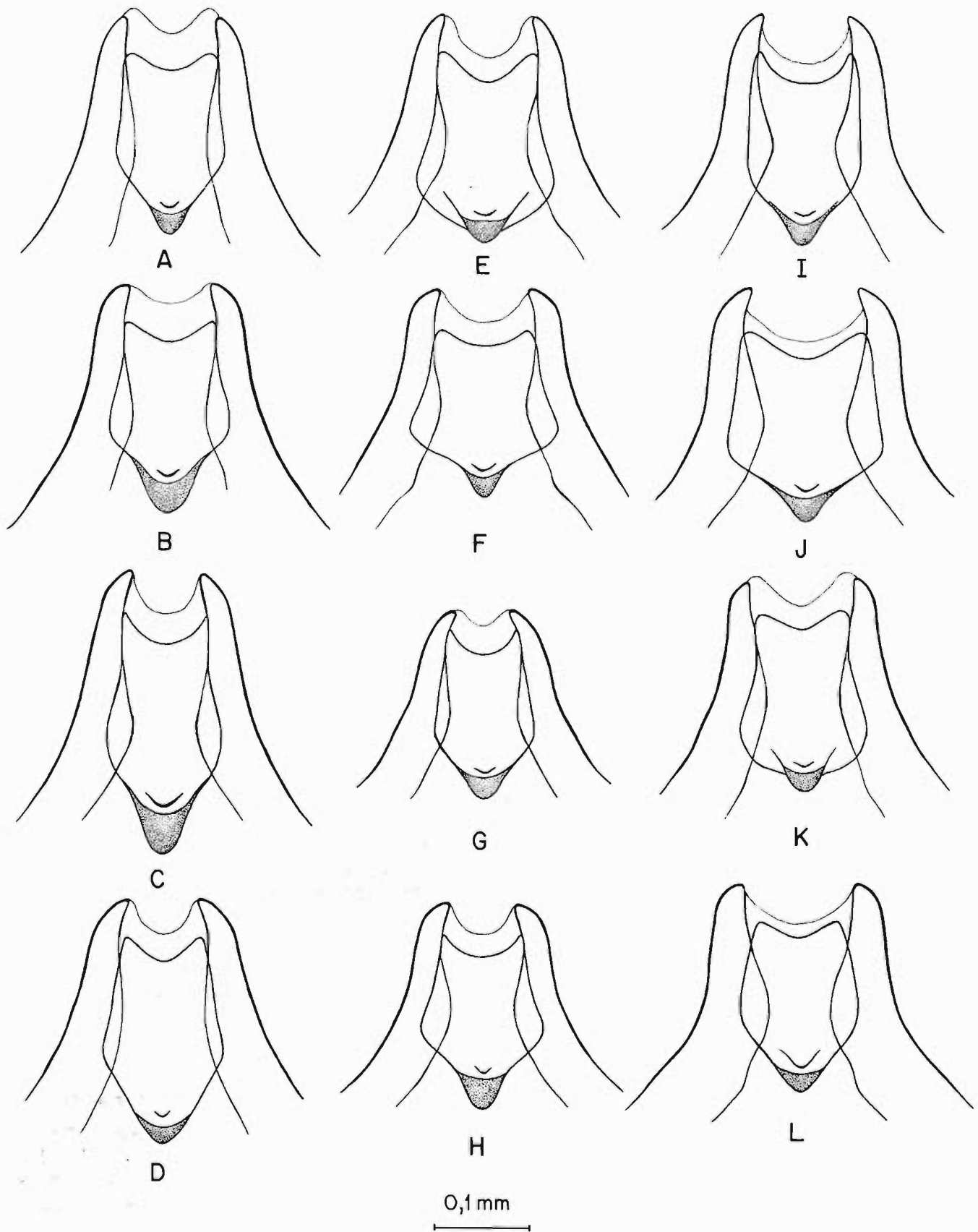


Fig. 1.— Anterior part of the head of: A) *Puffinoecus kosswigi* (Timmermann) male; B) *P. kosswigi* female; C) *P. jamaicensis* (Timmermann) male; D) *P. orientalis* (Uchida) male; E) *P. puellulus* (Timmermann) male; F) *P. puellulus* female; G) *P. minor* (Kellogg et Kawanana) male; H) *P. minor* female; I) *P. persicus* (Timmermann) male; J) *P. persicus* female; K) *P. peusi* Eichler male; L) *P. peusi* female.

Paratypes: 16 specimens males and females with the same data (only some of the latter have been checked).

Material examined: 1 male and 12 females, paratypes on *Puffinus p. yekkouan* (Acerbi). Aegean Sea, June 1935. Slide 3781 (N.H.M.).

Figures: 1 A-B, 3E, 4E, 5E, 6B, 7A.

Measurements: of 11 specimens 1 male and 10 females (paratypes): male: TL = 1,71; AB = 0,82; HL = 0,61; TB = 0,60; CI = 0,98; PL = 0,22; MB = 0,27; females (10): TL = 1,76-2,15 ($\bar{X} = 2,03 \pm 0,12$); AB = 0,82-1,04 ($\bar{X} = 0,96 \pm 0,06$); HL = 0,63-0,68 ($\bar{X} = 0,66 \pm 0,02$); TB = 0,65-0,70 ($\bar{X} = 0,68 \pm 0,01$); CI = 1,00-1,06 ($\bar{X} = 1,03 \pm 0,02$).

Male: Head with smoothly angled osculum; clypeal plate with lateral edges almost straight and the posterior ones weakly elongated (Fig. 1A); the conical appendix projecting from the postantennal suture beyond the middle of the broad and stout mandibles.

Thorax and abdomen with the same features as in the genus. Small, subpentagonal metasternal plate, with two anterior and one posterior setae. Posterior margin of pterothorax with 16 setae, alternating one long and one short at each side, the central ones being long. Abdominal chaetotaxy: tergal setae: II, 1+1; III, 2+2; IV, 4+5; V,

4+4; VI, 2+3; VII, 1+1; VIII, 0+0; pleural setae (at each side): III, 1; IV, 2; V-VI, 3; VII-VIII, 2; sternal setae: IV, 1+1 spiniform; V-VI, 1+1 medium and 1+1 spiniform; VII, 1+1 long. Postspiracular setae on segments IV-VIII. The number and arrangement of setae on the terminal segments as in Fig. 6B (a and b).

Genitalia stocky (Fig. 3E); basal plate extended, wide arms with their outer edges convex; short and thick parameres, curved in 2/3 of their total length, not narrowed at the proximal area to its head (Fig. 4E). Endomer complex broad, with outer edges convex; the inner lateral projections are quite obvious, but not fused medianly (Fig. 3E and 5E); hypomere long, with short penis beyond the endomer point, without telomeres. Warty sclerotisations with a cactus-like appearance.

Female: Presents a faintly sexual dimorphism evident in the clypeus (Fig. 1B), less pronounced osculum, lateral margins weakly convex, conical appendix longer and stouter. Abdomen wider than the male. The genital plate and chaetotaxy of the terminal segments as in Fig. 7A. Abdominal chaetotaxy: tergal setae: II, 1+1; III-VII, 3+3; VIII, 1+1; pleural setae: same number and arrangement as the male; sternal setae: IV, 1+1 spiniform, minute; V, 1+1 medium; VI, 2+2 long; VII, 1+1 long located at the edge of the genital plate.

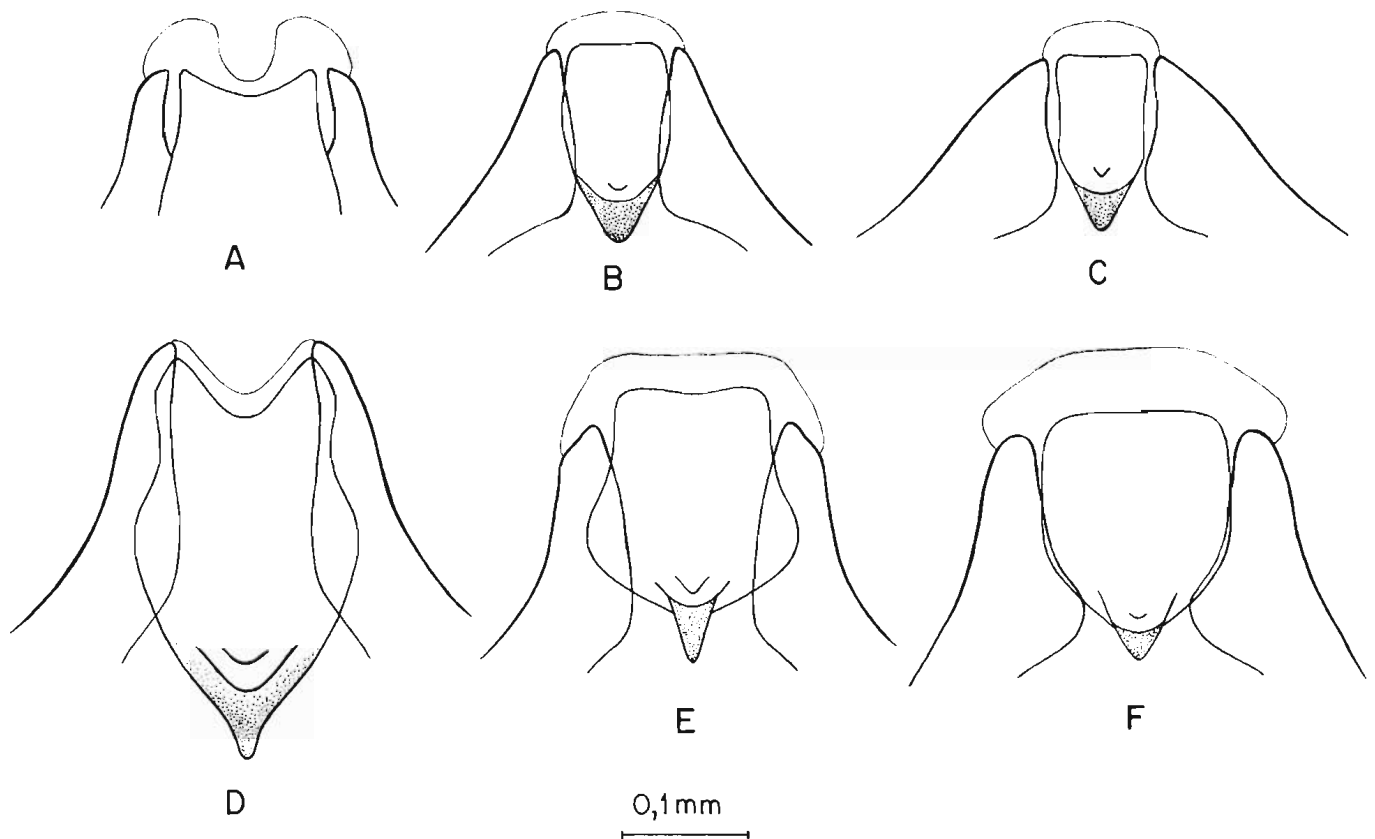


Fig. 2.— Anterior part of the head of: A) *Saemundssonina desolata* (Timmermann); B) *S. occidentalis* (Kellogg); C) *S. gaini* (Neumann) (all of them according to TIMMERMAN, 1965); D) *S. upoluensis* (Rudoww); E) *S. muelleri* Eichler; F) *S. integer* (Nitzsch).

***Puffinoecus minor* (Kellogg et Kuwana, 1902)**

References: *Docophorus validus* var. *minor* Kellogg et Kuwana, 1902: 460. *Philopterus minor* (Kellogg et Kuwana) (HARRISON, 1916: 99). *Saemunssonia minor* (Kellogg et Kuwana) (HOPKINS & CLAY, 1952: 333; TIMMERMANN, 1965: 81; EMERSON, 1972: 161;

LEDGER, 1980: 137). *Puffinoecus minor* (Kellogg et Kuwana) (MEY 1989: 54). The original description of this species as a variety of *D. validus* on *Puffinus lherminieri subalaris* Ridgway, is very brief and only reported that this new variety has approximately 2/3 the size of the «original form» length, but has the same general features and morphology.

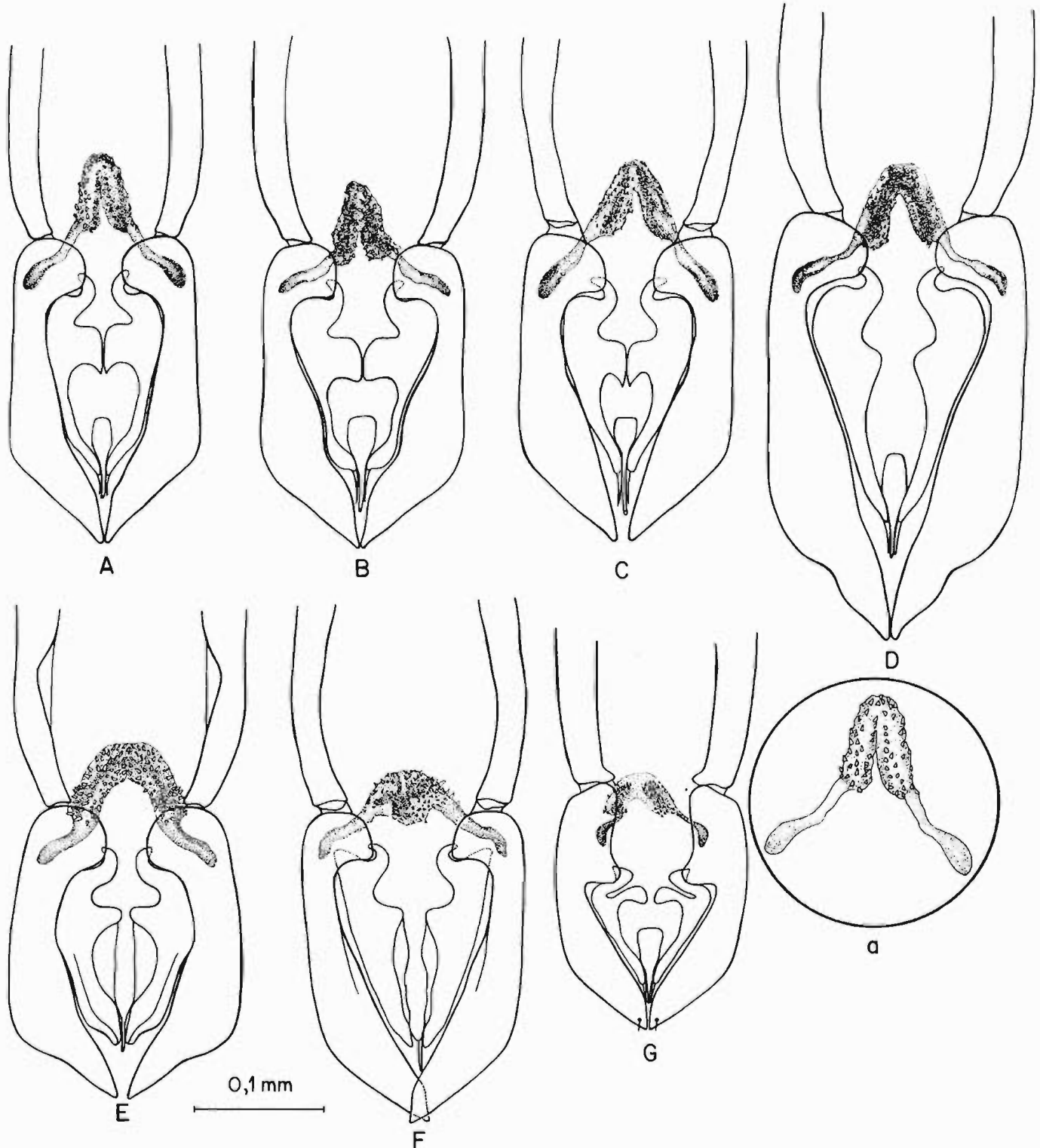


Fig. 3.— Male genitalia of: A) *Puffinoecus peusi* Eichler; B) *P. minor* (Kellogg et Kuwana); C) *P. orientalis* (Uchida); D) *P. jamaicensis* (Timmermann); E) *P. kosswigi* (Timmermann); F) *P. persicus* (Timmermann); G) *P. puellulus* (Timmermann). a = detail of sclerotisations of the genital sac.

Material examined: 1 male and 1 female on *Puffinus lherminieri subalaris* Ridway from the island of Santa Cruz, Galapagos. 13-II-1964. Coll. D. Snow Slide 1964-424 (M.N.H.).

Figures: 1G-H, 3B, 4B, 5B, 6C, 7B.

Measurements: male (1): TL = 1,47; AB = 0,67; HL = 0,55; TB = 0,54; CI = 0,98; PL = 0,22; MB = 0,15; female (1): TL = 1,87; AB = 0,89; HL = 0,61; TB = 0,65; CI = 1,06.

Male: Head with rounded osculum, clypeal plate with lateral edges almost parallel, posterior margin acuminate (Fig. 1G); warty appendix broad at the base, narrowing at the apex, which almost exceeds the mandibles.

Thorax and abdomen with the genus characteristics. Metasternal plate, with two middle setae. Tergal plates of the terminal segment according to Fig. 6 Ca. Pterothorax with 6+6 setae in its inferior edge, laterally arranged, the first and third of each side shorter than the rest. Abdominal chaetotaxy: tergal setae: II, 2+1; III-V, 3+3; VI, 3+2; VII, 2+2; pleural setae (at each side): IV-V, 2; VI-VIII, 3; sternal setae: IV, 1+1 (minute, spiniform); V-VI, 2+2 medium; VII, 1+1 long. Postspiracular setae located on segments IV-VII. The number and arrangement of the terminal setae as in Fig. 6C (a and b).

Genitalia (Fig. 3B), formed by a basal plate with subparallel arms and straight edges, parameres narrowing at the part proximal to the head, straight outer edges and the inner ones curved, widened in the posterior two thirds of their length (Fig. 4B); endomeres joined to the parameral margins, inner projections are joined in the middle constituting a bridge (Fig. 3B); short hypomere, from which the penis emerges, with telomeres shorter than penis. The warty sclerotisations have a tree-like shape.

Female: Head with the clypeus slightly different from the male, broader osculum, lateral edges weakly expanded in the inferior third part; posterior margin more acuminate (Fig. 1H); finger-like appendix shorter and thicker than the male, reaching the middle zone of the mandibles. Thorax and abdomen with the characters described as typical of the genus. Metasternal plate as in the male. Genital plate as in Fig. 7B. Pterothorax with 6+5 lateral, long setae, with same length. Abdominal chaetotaxy: tergal setae: II, 1+1; III-VI, 3+3; VII, 2+2; VIII, 1+1; sternal setae: IV, 1+1 minute, spiniform; V, 2+2 the external spiniform; VI, 2+2 medium; VII, 1+1 long placed at the margin of the genital plate. Pleural and postspiracular setae as in the male. Number and position of the setae of the terminal segments as in Fig. 7B.

Puffinoecus orientalis (Uchida, 1948)

References: *Philopterus validus* var. *orientalis* Uchida, 1948: 551. *Saemundssonina orientalis* (Uchida) (HOPKINS & CLAY, 1952: 334; TIMMERMANN, 1962: 427, 1965: 80). *Puffinoecus orientalis* (Uchida) (MEY

1989: 54). Described as *Philopterus validus* var. *orientalis* on *Puffinus leucomelas* (Temminck); it is not well characterized. Its author only outlines the male genitalia and states that the females have a head that is broader than long.

Material examined: 1 male, paratype on *Puffinus leucomelas* (Temminck) from Japan. Slide 1953-687 (N.H.M.).

Figures: 1D, 3C, 4C, 5C, 6D.

Measurements: from the male specimen studied: TL = 1,78; AB = 0,90; HL = 0,66; TB = 0,65; CI = 0,98; PL = 0,24; MB = 0,16.

Male: Head thickening at the level of the temples, with a narrow, rounded osculum; clypeal plate with lateral margins faintly convex at its lateral angles; the posterior one weakly acuminate (Fig. 1D).

Thorax with the characteristic features of the genus: ovoid metasternal plate, with two long setae. Abdomen almost circular. Tergal plates of the terminal segment as shown in Fig. 6 Da. Pterothorax with 7+7 long setae in its inner edges, with the same length and laterally located. Abdominal chaetotaxy: tergal setae: II, 1+1; III-VII, 3+3; pleural setae (at each side): III, 1 spiniform; IV-VIII, 3; sternal setae: IV, 1+1 minute, spiniform; V-VII, 2+2, longer than the subsequent sternite ones. Postspiraculars on segments IV-VII. Number and position of the setae on the terminal segments as in Fig. 6D (a and b).

Genitalia (Fig. 3C), formed by a basal plate with its arms relatively narrow, with edges almost straight; parameres narrowed at the part proximal to the head and thickened in their inferior third, with straight edges (Fig. 4C); inner endomeral projections quite distinct, joined forming a bridge, with posterior angles very acute (Fig. 5C); short hypomere from which a moderately long penis appears, with the telomeres present. Warty sclerotisations vertical, raised, perfectly delimited in two cactus-like branches.

Female: not studied.

Puffinoecus persicus (Timmermann, 1962)

References: *Saemundssonina persica* Timmermann, 1962 (TIMMERMANN, 1962: 430, 1965: 80; EMERSON, 1972: 161; LEDGER, 1980: 137; both latter as synonyms of *S. minor*). *Puffinoecus persicus* (Timmermann) (MEY, 1989: 54).

Material: Holotype male and allotype female on *Puffinus lherminieri persicus* Hume, Persian Gulf. 31-III-1954. Coll. D.R. Pochin Slide 1954-425 (N.H.M.). Paratypes, 6 specimens, males and females with the same data (partially examined).

Material examined: 1 male and 3 females, paratypes, on *Puffinus persicus* from the Persian Gulf, 31-III-1954, Coll. D.R. Pochin slide 1954-452 (H.N.H.).

Figures: 1I-J, 3F, 4F, 5F.

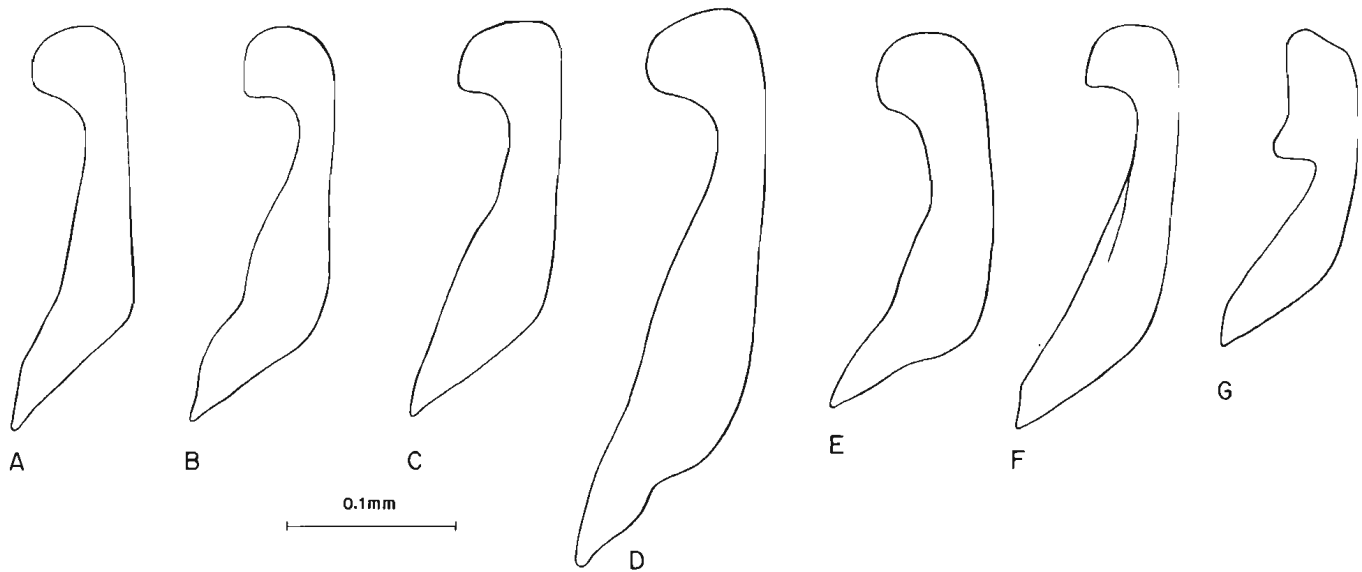


Fig. 4.— Outline drawing of the parameres of: A) *Puffinoecus peusi* Eichler; B) *P. minor* (Kellogg et Kuwana); C) *P. orientalis* (Uchida); D) *P. jamaicensis* (Timmermann); E) *P. kosswigi* (Timmermann); F) *P. persicus* (Timmermann); G) *P. puellulus* (Timmermann).

Measurements: 1 specimen male: HL = 0,63; TB = 0,65; CI = 1,03; PL = 0,24; MB = 0,17; the total length and breadth have not been measured since the specimen studied had a distorted abdomen because of the mounting and the dissection of the genitalia; females (3): TL = 1,96-2,11 ($\bar{X} = 2,06 \pm 0,07$); AB = 1,02-1,12 ($\bar{X} = 1,05 \pm 0,05$); HL = 0,64-0,65 ($\bar{X} = 0,65 \pm 0,008$); TB = 0,69-0,75 ($\bar{X} = 0,71 \pm 0,02$); CI = 1,06-1,15 ($\bar{X} = 1,09 \pm 0,04$).

Male: Head with rounded osculum, clypeal plate with lateral edges straight and the posterior one heavily pointed (Fig. 1I); conical appendix relatively stout and long, running towards the middle of the mandibles.

Thorax and abdomen with the same characteristics as the genus. Elongated metasternal plate, with four setae.

Pterothorax bearing 19 setae in the posterior margin, alternating long and shorter ones. Abdominal chaetotaxy: tergal setae: II, 1+1; III-VII, 3+3; pleural setae (at each side): IV-VII, 3; sternal setae: not visible in the specimen checked. Postspiracular setae on segments IV-VII. The terminalia of the male studied was faulty because of the dissection of the genitalia, so it was not possible to observe its plates and setae.

Genitalia (Fig. 3F), formed by a basal plate with thin and slightly curved arms, long and thin parameres narrowed at the part proximal to the head (Fig. 4F); inner endomerical projections not very distinct and clearly separated at the middle (Fig. 3F and 5F); moderately long penis going out from the hypomere, without telomeres. Broad warty sclerotisations not vertically raised, but prolonged towards the basal plate.

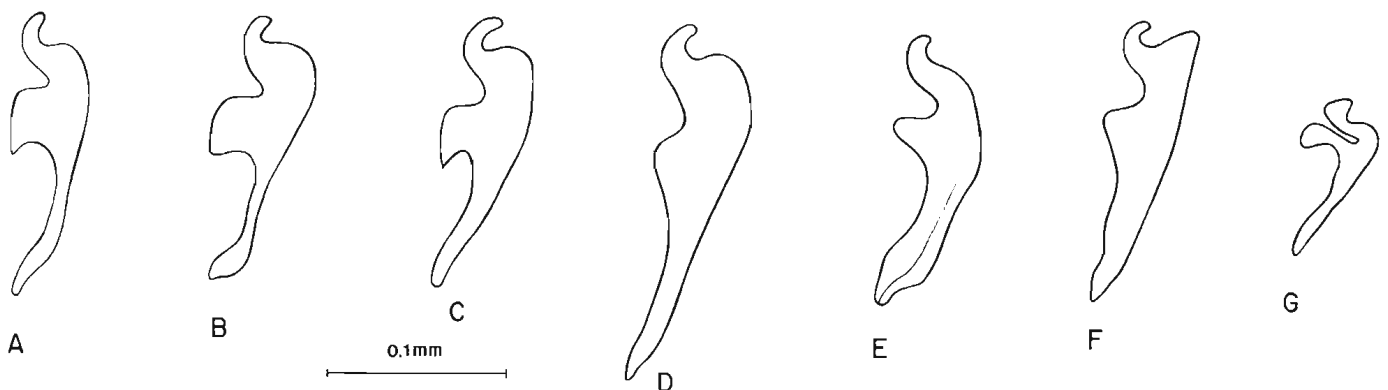


Fig. 5.— Outline drawing of the endomereres of: A) *Puffinoecus peusi* Eichler; B) *P. minor* (Kellogg et Kuwana); C) *P. orientalis* (Uchida); D) *P. jamaicensis* (Timmermann); E) *P. kosswigi* (Timmermann); F) *P. persicus* (Timmermann); G) *P. puellulus* (Timmermann).

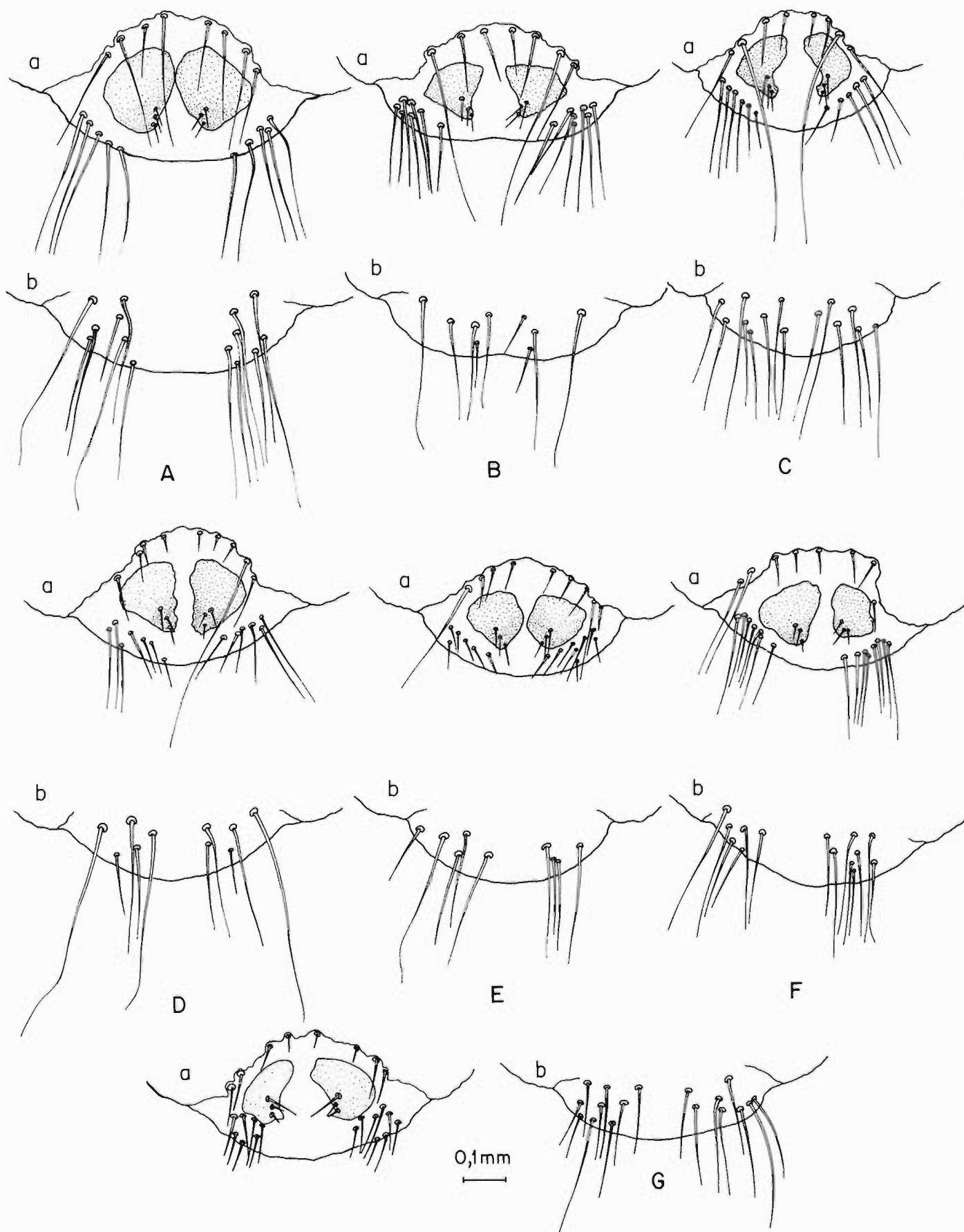


Fig. 6.- Terminal abdominal segment of the males of: A) *Puffinoecus jamaicensis* (Timmermann); B) *P. kosswigi* (Timmermann); C) *P. minor* (Kellogg et Kuwana); D) *P. orientalis* (Uchida); E) *P. peusi* Eichler; F) *P. puellulus* (Timmermann); G) *P. nadleri* Mey (new synonym). a = dorsal view showing tergal plates and setae; b = ventral view showing setae.

Female: Widened head both in the clypeal zone as well as at the level of the temples; broad osculum; clypeal plate wider than the male; lateral edges straight and the posterior one not markedly pointed (Fig. 1J); conical appendix stout and relatively short.

Thorax and metasternal plate as in the male. Broad abdomen. Abdominal chaetotaxy: tergal setae: II, 1+1; III, 3(4)+3; IV-V, 4(3)+3(4); VI-VIII, 3; sternal setae: III, 1+1; IV, 4+4; V-VI, 2+2; VII, 1+1. Postspiracular setae on segments IV-VII.

***Puffinoecus peusi* Eichler, 1949**

References: *Puffinoecus peusi* Eichler, 1949 (EICHLER, 1949: 13). *Saemundssonina peusi* (Eichler) (HOPKINS & CLAY, 1952: 334; TIMMERMANN, 1962: 427; 1965: 80; EMERSON 1972: 162; MARTIN MATEO, 1977: 154; ZLOTORZYCKA, 1978: 49; LEDGER, 1980: 137). *Puffinoecus peusi* Eichler (MEY 1989: 56). Because *P. peusi* is the *typus generis* for *Puffinoecus*, the morphological characters of this species are given in the general description of the genus; however, in the descriptions of *P. peusi* and the other species, only the specific characters (measurements, chaetotaxy, etc.) are given.

Material: Holotype not designated. Cotypes 2 males, 1 female on *Puffinus diomedea diomedea* (Scopoli) from Dalmacia, 8-IX-1938. Coll. F. Peus Slide 877 (N.H.M.) (partially checked).

Material examined: 2 males, paratypes, on *Puffinus diomedea diomedea* (Scopoli), from Dalmacia, 8-IX, 1938, Coll. F. Peus slide 1949-444,877 (N.H.M.); 1 male, 2 females, from the Columbrete Grande island, (Spain), 22-IV-1964. Peris and Compte leg. (M.N.C.N.); 1 male, from the island of Sardinia (Italy). s.f. Manilla leg (M.N.C.N.); found on the same host.

Figures: 1K-L, 3A, 4A, 5A, 6E, 7C.

Measurements: male (4): TL = 1,56-1,78 (\bar{X} = 1,66 \pm 0,23); AB = 0,70-0,90 (\bar{X} = 0,79 \pm 0,07); HL = 0,59-0,67 (\bar{X} = 0,63 \pm 0,04); TB = 0,59-0,63 (\bar{X} = 0,60 \pm 0,02); CI = 0,89-1,00 (\bar{X} = 0,96 \pm 0,05); PL = 0,21-0,25 (\bar{X} = 0,23 \pm 0,02); MB = 0,15-0,17 (\bar{X} = 0,16 \pm 0,009); females (2): TL = 1,96-2,00 (\bar{X} = 1,98); AB = 1,07; LC = 0,63-0,67 (\bar{X} = 0,65); TB = 0,67; CI = 1,00-1,06 (\bar{X} = 1,03).

Male: Both the head osculum as well as the anterior margin of the clypeal plate are angled, concave; lateral edges expanded in their rounded inferior mid-part; posterior edge hardly acuminate (Fig. 1K); conical appendix stout and short, scarcely overpassing the beginning of the mandibles.

Thorax and abdomen with the generic characteristics. Metasternal plate with ameboid shape, bearing two central setae. Pterothorax with 5(6)-6(7) long setae placed laterally at the inner edge. Abdominal chaetotaxy: tergal setae: II, 1+1(2); III-VI, 3+3 (2 on segment VI in 3 spe-

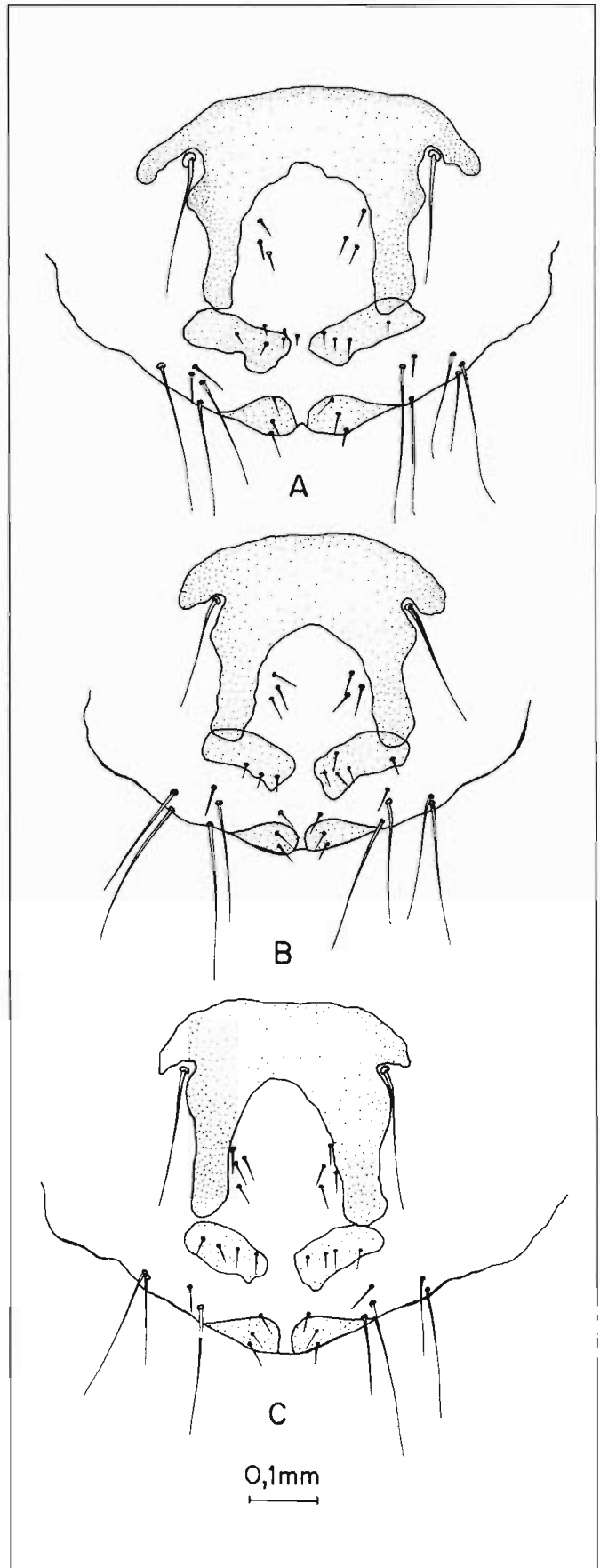


Fig. 7.— Genital plate and terminal setae of females of: A) *Puffinoecus kosswigi* (Timmermann); B) *P. minor* (Kellogg et Kuwana); C) *P. peusi* Eichler.

cimens); VII, 2+2(3 in two specimens); pleural setae (at each side): III, 1 spiniform; IV-VIII, 3 (4 in one specimen); sternal setae: III, 1+1 minute, spiniform; IV-V, 2+2, spiniform; VI, 2+2 medium; VII, 1+1 with a greater length. Postspiracular setae on segments III-VII. Number and arrangement of the setae on the terminal segments as in Fig. 6E (a and b).

Genitalia (Fig. 3A) with broad basal plate, its arms almost parallel, with straight edges. Stout parameres deeply narrowed at the part proximal to the head, expanded in the second third of its length (Fig. 4A); inner endomerall projections joined at the middle, forming a bridge (Fig. 3A); the penis arises from a short hypomere, with two thin stiletto-like telomeres. Warty sclerotisations projecting upwards in two tree-like branches markedly differentiated.

Female: Presents a faintly sexual dimorphism evident in the clypeus. Head with the anterior margin and the clypeal plate broader and rounder than the male, lateral edges convex and the posterior one clearly acuminate (Fig. 1L). Conical appendix similar to the male one. Thorax and metasternal plate as in the male. Abdomen faintly wider. Abdominal chaetotaxy resembles the male very much although with a higher number of setae, specially tergal ones. Genital plate and terminalia as in Fig. 7C.

Puffinoecus puellulus (Timmermann, 1965)

References: *Saemundsson* *puellula* Timmermann, 1965 (TIMMERMANN, 1965: 82; EMERSON, 1972: 163; LEDGER, 1980: 137). *Puffinoecus puellulus* (Timmermann) (MEY, 1989: 54). *Puffinoecus nadleri* Mey, 1989 (MEY, 1989: 54), new synonymy. Holotype male (slide M.3219c), Atlantic (58° S, 54° W), 11-XII-1986; allotype female (slide M.3215g with paratypes). Atlantic (33° 5' S, 47° 5' W) 3-XII-1986, T. Nadler and H. Mix leg (N.M.R.); paratypes

8 males, 13 females and 3 larvae (slide Mey, 3215 a-k) Atlantic (33° 5' S, 47° 5' W), 3-XII-1986 and 4 females, 1 larva (slide M.3219, a-f), Atlantic (58° S, 54° W), 11-XII-1986. All on *Ardenna gravis* (O'Reilly, 1818).

Material: Holotype male and allotype female, paratypes 1 male, 1 female on *Puffinus pacificus cuneatus* Salvin, Johnston I. (17° N, 169° W), 20-VIII-1963 (M.N.H.).

Material examined: 1 male, 1 female on *Puffinus p. pacificus* (Gmelin), Is. Meyer, Kermadecs. 20-XII-1966, DSIR.N.Z., slide: 1970-208 (N.H.M.). 2 males and 3 females (paratypes) on *Puffinus gravis* (O'Reilly), Atlantic (33° 5' S, 47° 5' W), 3-XII-1986, T. Nadler leg., slides 3215 a and c (N.M.R.).

Figures: 1 E-F, 3G, 4G, 5G, 6F.

Measurements: see Table 1.

Male: Head with a very deep and rounded osculum; clypeal plate with lateral margins divergent and the posterolateral angles rounded (Fig. 1E); conical appendix stout and quite long, projecting towards the middle of the mandibles.

Thorax and abdomen rounded, with the typical characteristics of the genus. Metasternal plate ovoid, bearing two setae located in the anterior margin. Pterothorax with 6(7)+6 long setae arranging laterally within the posterior edge. Abdominal chaetotaxy: tergal setae: II, 1+1; III-VI, 3+3; VII, 1+1(2); pleural setae (at each side): II, 1 small, spiniform; IV-V, 2; VI-VII, 3-4; VIII, 3; sternal setae: III, 1+1 minute, spiniform; IV-VI, 2+2 small but increasing progressively in size at the posterior segments; VII, 1+1 long at the edge of the genital plate. Postspiracular setae on segments IV-VII. Number and arrangement of the setae of the terminal segments as shown in Fig. 6F a and b.

Genitalia (Fig. 3G) with broad basal plate; parameres short, characterised by a long head and strongly nar-

Parameters	<i>P. puellulus</i>		<i>P. nadleri</i>	
	Male (n = 1)	Female (n = 1)	Male (n = 2)	Female (n = 3)
TL	1,67	2,03	1,63	1,78 - 1,92 (\bar{X} = 1,84 ± 0,06)
AB	0,78	1,00	0,81	0,81 - 0,92 (\bar{X} = 0,86 ± 0,04)
HL	0,63	0,67	0,63	0,67 - 0,70 (\bar{X} = 0,68 ± 0,01)
TB	0,63	0,70	0,63	0,67 - 0,70 (\bar{X} = 0,68 ± 0,01)
CI	1,00	1,04	1,00	1,00
PL	0,19		0,18	
MB	0,15		0,15	
PHL*	0,08		0,08	

Table 1.— Comparative measurements of *Puffinoecus puellulus* (Timmermann) and *Puffinoecus nadleri* Mey (new synonym). * PHL = parameres head length.



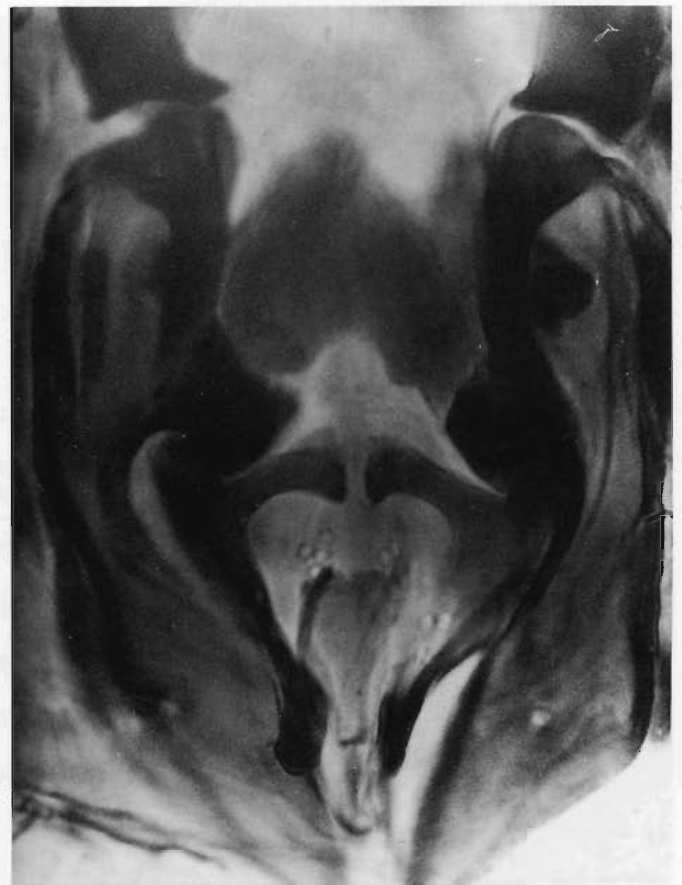
A



C



B



D

Fig. 8.— Male genitalia of: A, B) *Puffinoecus nadleri* Mey (new synonym); C, D) *P. puellulus* Timmermann. A, C: x 125; B, D: x 250.

wed at the zone proximal to the head (Fig. 4G); peg-shaped inner endomerale projections, unfused (Fig. 3G); hypomere short, projecting a not very long penis, with the telomeres overpassing it.

Female: Similar to the male. Head with broader osculum; clypeal plate wider than the male, the lateral edges more divergent and the posterior ones more pointed (Fig. 1F).

Thorax as in the male, ovoid metasternal plate, bearing two long central setae. Oval-shaped abdomen is narrower. The number of both the setae of the pterothorax and the abdominal chaetotaxy are similar; the arrangement of the abdominal tergal setae is more lateral following the pattern of all the females of the genus.

Remarks: The description and figures of *P. nadleri* Mey, 1989 coincide almost completely with the morphological characters observed on the material of *P. puellulus*, specially the typical shape of the male genitalia (parameres with a considerably elongated head), only the hyaline cuticle with straight edge of the head's anterior zone that MEY points out in his description could be an appreciable difference.

The study of the specimens (paratypes) of *P. nadleri*, kindly loaned by Dr. Mey, confirms the resemblance observed in the description. Both the morphological characters of the male genitalia as well as the dimensions (Table 1) and the chaetotaxy of the studied material of the two species are practically identical. There are only a few small differences in the number and arrangement of setae of the male terminal segments (Fig. 6 a and b) of the examined material of *P. nadleri*, which we do not consider significant enough for making a specific differentiation.

On the other hand, in the specimens of *P. nadleri*, the straight, anterior, hyaline margin of the head cited by MEY (1989: «Zwischen dem Vorderrand der Clypealsignatur und der Marginal carina bzw. dem Vorderkopfende spannt sich eine hyalina Haut mit anterior geraden Rand») has not been found, but this hyaline margin is clearly concave.

Taking all this information into account, we have considered *P. nadleri* Mey 1989 as a synonym of *P. puellulus* Timmermann, 1965.

Other species

The remaining species belonging to the genus *Puffinoecus*, listed by MEY (1989), *P. enderleini* Eichler, 1949 and *P. validus* (Kellogg et Chapman, 1989), have not been discussed in this paper because we have not been able to obtain specimens of these species. The following taxonomic data about them have been taken from the literature (TIMMERMANN, 1965).

***Puffinoecus enderleini* Eichler, 1949:** *Bull. Soc. Ent. Ital.* 79: 13. Host: *Pterodroma mollis* (Gould). This species was found by EICHLER (1949) on *Dochophorus*

schillingi Enderlein, and wrongly determined by RUDOW (1866) as *Trabeculus schillingi*. According to ENDERLEIN's description and figures (1909), it belongs clearly to the genus *Puffinoecus*, but lacking enough taxonomic data especially the male genitalia, to be included in the key of the species.

***Puffinoecus validus* (Kellogg et Chapman, 1899):** (*Docophorus*) *Occ. Pap. Calif. Acad. Sci.*, 6: 56, 5 lam., 2 fig. Host: *Puffinus opisthomelas* Cones. Large species of *Puffinoecus*, with its frontal region relatively short and blunt, described from a single female specimen. Because of this it is difficult to ascertain whether this species belongs to the genus *Puffinoecus* on account of the resemblance of the females of the genus. The measurements of the holotype, according to KELLOGG & CHAPMAN (1899) are: TL = 2,25; HL = 0,72; TB = 0,72; CI = 1,00.

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