A Contribution on the Genus *Aphytis* Howard in South Africa. (Hymenoptera : Aphelinidae)

by

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INTRODUCTION

The cosmopolitan genus *Aphytis* Howard comprises approximately 50 species of which 13 are known to occur in South Africa. This paper presents a survey of the species found in this country and of some other species imported from overseas as an aid to the biological control of certain citrus scale insect pests in South Africa. The paper also attemps to supply the need for up-to-date keys for the determination of the species encountered in orchards infested with diaspine scales. For this purpose comparatively few publications were available in the past. A fundamental study of the systematics of the genus *Aphytis* was made by Compere (1955) whose paper may still be regarded as a standard for future work. The development of new methods of preparation and of more detailed studies with the phase-contrast microscope have revealed a number of subtle but rather reliable characters which aid in the morphological characterization of the species (De Bach *et al.*, 1959, 1960, 1961). It is in this modern avenue that this paper proceeds. Systematics is indeed an evergrowing science, and all efforts should be aimed at improving our techniques for distinguishing such cryptic species as are contained in the genus *Aphytis*.

MORPHOLOGICAL CHARACTERS IN THE GENUS *APHYTIS*

As in many other genera of the micro-Hymenoptera, the systematics of the genus *Aphytis* is difficult. Many species have apparently not completed their evolution, and in some groups differentiation of species is possible only by means of rather cryptic characters. On the other hand, however, there are quite a number of distinct species, well provided with conspicuous and stable criteria. In certain evidently younger groups of species, particularly in the so-called *chrysomphali*-group, the pigmentation of the pupa is of great importance for the recognition of the species (De Bach, 1959, 1960). The terminology used in the following discussion is in accordance with Compere (1931). There is considerable

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variation in the characters used for the classification of the species, sometimes even with an overlapping of the extremes of such characters in two closely related species, and it may be more difficult to identify a single specimen than a group of individuals from the same source where the range of variation can be studied.

In *Aphytis* sexual dimorphism is little developed. The males usually have a different number of rhinaria (less or more than the female) on the antennal club, but otherwise there are only primary sexual differences. The colour of the body is the same in both sexes, namely bright yelllow to orange-yellow to greyish or brownish, sometimes more or less plainly maculate. The pigmentation of the integument seems to be rather stable and characteristic for the species. The head is pale or somewhat infuscated with or without black bars at the occipital region. In some species, particularly in the *proclia*-group, the body is provided rather densely with dark pigmented areas on head and thorax, and there are also dark transverse bands on the abdomen. In these species legs and antennae are also darkened. There is a tendency to reduce the dark pigmentation throughout the whole genus, leaving the thorax somewhat mottled and the abdomen more pale, while the tips of the antennae appear more deeply infuscated. In many species of the *chrysomphali*-group and the *mytilaspidis*-group there are dark pigments only at the hind margin of the scutellum and ventrally in the middle of the sternal plates (especially propleuron, mesosternal furca and metasternum). In other species dark body pigments are entirely lacking in the adult form (*A. fisheri* De Bach, *melinus* De Bach and *holoxanthus* De Bach). Sometimes the separation of closely related species is possible from a consideration of the pigmentation of the pupa. It is necessary to study the older pupae since some of the pigments appear towards the end of the pupal stage and do not show in the young forms. The ventral side of head, thorax and abdomen of many species may be predominately blackish. In some species the head is pale, or head and abdomen together, while the thorax is black, as in *A. melinus*, or the pupa is entirely yellowish without pigmentation, or has only faint marks on the mesosternum (*A. lepidosaphes* Compere, *fisheri*, *chrysomphali*).

The antennae are six-, seldom five-segmented, with long, linear rhinaria on the last funicle segment and the club, their number varying from three to 30. On the thorax the number of bristles on the mesoscutum is of some taxonomic value, but there is a great deal of variation. There are from eight to 40 mesoscutal bristles in the different species. The propodeum or first abdominal segment shows one pair of dorsal spiracles. There is also one pair of flattened hairs cephalad to the stigma, and one to three hairs laterally below the stigma on either side. The hind margin of the propodeum is differentiated into a fringe of scale-like structures, called crenulae, the shape and number of which sometimes gives quite good distinguishing characters. There are nine visible segments of the abdomen with dorsolateral spriacles on the first and eighth segment. On the lateral parts of the syntergum there is a bundle of longer hairs on either side, arising from the cercal plates, each consisting of two, or rarely three (*A. cercinus* Compere), long bristles with one that is always short. The lateral (marginal) hairs on the abdominal segments vary from two to 10 per segment on each side. There are also dorsocentral hairs on segment VII and VIII, with one or two pairs developed. Towards the

end of the syntergum the hairs appear more numerous and are therefore of little taxonomic value. The ovipositor skeleton is complicated and rather uniform throughout the genus, except for the excessively developed basal plates in *Aphytis merceti* Compere. The ratio length of gonostyli to length of mid-tibia sometimes gives an additional criterion in some species, but is rather uniform in the majority of the members of the group. The male genitalia do not afford any characters for the separation of species.

The structure of the wing can facilitate the recognition of certain species, although in many species the wings are extremely similar. As in all Chalcidoidea the wing venation is greatly reduced, and there is only one marginal branch developed, the sections of which are called submarginal, marginal, and stigmal vein, respectively. A number of long hairs are placed at the outer margin of the marginal vein and along its middle. The edge of the membranous disc is provided with a fringe of hairs often of characteristic length, and the ratio of longest hair of fringe to the greatest width of the disc may be useful. Below the marginal vein, basad to a hair-free zone called the speculum, there is the so-called delta-area with a greater number of bristles of medium length. The number of rows of these bristles may be characteristic. At the inner margin of the sub-marginal vein a number of circular cells appears. The number of these bullae is variable. The marginal fringe of unusually small individuals is relatively longer; also the breeding temperature may affect its length (Quednau, 1957). The wings are either completely hyaline, with only diffuse indications of dark colour below the submarginal vein, as in the *chrysomphali*-group and the *mytilaspidis*-group, or there are dusky areas distinctly developed, particularly below the stigmal vein and at the base of the delta-area. These spots may flow together so that the forewing appears to be banded in the middle. Extent and intensity of this pigmentation, however, can vary within a species to a considerable degree.

BIOLOGICAL NOTES

The species of the genus *Aphytis* live exclusively as ectoparasites of diaspine scale insects. Since this group of scale insects includes many scale pests of orchards, especially citrus, the parasites of the genus *Aphytis* are of great importance in regulating scale populations and reducing their numbers to a non-economic level. Biological control has been achieved in citrus orchards of California, Israel and South Africa with the help of these tiny but extremely valuable insects. Although in some places the parasites failed to become established the value of *Aphytis* species as controlling agent of diaspine scale pests is considerable. As stated by Compere (1955): "It seems evident that some pests would be far more injurious than they are at present were it not for the so-called ineffective parasites that preyed upon them."

The female parasite lays one or several eggs next to or on the surface of the scale body, after having pierced the scale cover with the ovipositor shaft. The stages of scale preferred for parasitization are the young or producing female scales, and the second instar male scales. Moult stages and small developmental

stages, as well as the male pupae are unsuitable for the development of the parasite, and the *Aphytis* female does not lay eggs into such scales. The young parasite larva hatches from the egg and feeds externally on the scale body, well protected by the scale cover. After consumption of all the host tissues the parasite pupates under the scale cover.

Meconium is formed during the last larval stage of the parasite and voided immediately prior to pupation. The fecundity of an *Aphytis* female may be over 100 eggs (usually on the average only 30-50 eggs), and the lifespan may be as long as one month under suitable climatic conditions. As an average one to three eggs are laid per day by a single female. In addition to the destruction of scales by parasitization a great number of scales of all stages is mechanically killed by the female parasite by mutilating the scale body from frequent insertions of the ovipositor without egg-laying. It is then that the parasite female may provide herself with proteins from the host by feeding on the body fluids of the csale.

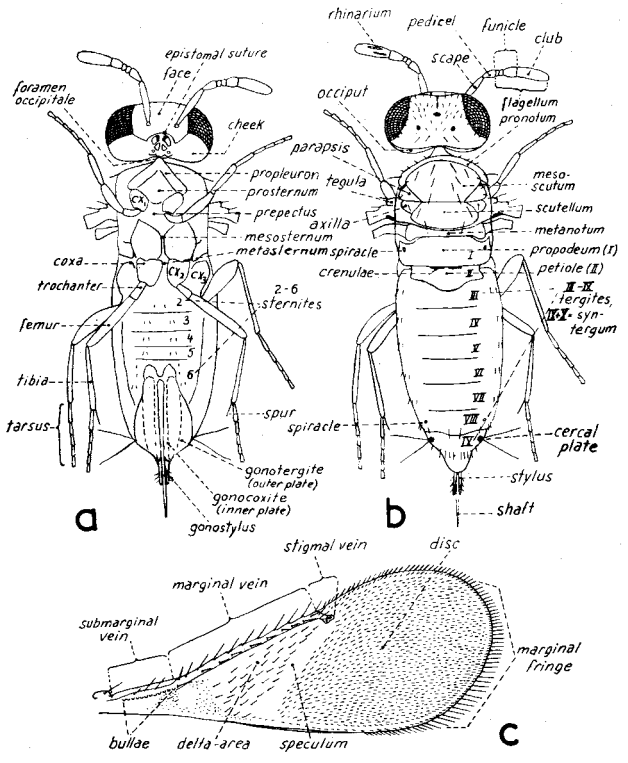


Fig. 1. *Aphytis holoxanthus* De Bach, terminology of morphological characters as used in text. The pattern of adult pigmentation shown here also applies to *A. melinus* De Bach and *A. fisheri* De Bach.

a. Body of female, ventral view; **b.** body of female, dorsal view; **c.** front wing.

COLLECTION AND PREPARATION TECHNIQUES

The adults of the genus *Aphytis* are easily collected when scale infested plant material is put into an emergence-box with a semitransparent funnel and glass tube on one side in order to attract the emerging parasites phototropically, or the parasites may be collected into alcohol (pure, 80%) with a wet brush directly from the host plant. It is advisable to mount alcoholic specimens as soon as possible since prolonged storage in alcohol tends to bleach the pigments. It is an advantage to keep the specimens dry, after they were killed by ether or from starvation, and it is convenient to place them in a gelatine capsule pierced with an insect pin bearing a label with the name of the host and plant, and the date and locality of collection. Dried parasite material can be stored for a considerable period of time, but should be protected from sunlight. For microscopic studies permanent mounts of the parasites are necessary. The specimens, either alive, or dried, or from alcohol are placed directly into Chloralphenol, a saturated solution of Chloralhydrate in Phenolum liquefactum, for maceration, which in such small specimens may be complete within a few hours. Caustic soda is not so suitable for clearing, since an uncontrolled application will always harm the pigments, while a prolonged immersion in Chloralphenol has no disadvantages. From Chloralphenol the insects are directly mounted on slides in a modified Faure solution (arabic gum 12g, chloralhydrate 20g, acetic acid glacial 5 ccm, 50% w/w glucose syrup 5 ccm, distilled water 40 ccm, these ingredients to be mixed at 100°F. and filtered through glasswool). The mounting medium should have the proper viscosity in order to avoid shrinkage or undue flattening of the insects. It is advisable to draw a ring of Faure solution on the glass slide, the centre of which is filled with Chloralphenol. Into this centre the specimens are transferred from the clearing bath by means of fine pointed forceps. Then the coverglass is applied from the top, thus preventing the specimens from gliding away, and allowing both fluids to mingle. The specimens can also be microscopically examined in Chloralphenol when a hollow-ground glass slide is used. It is noteworthy that a water-soluble mounting medium has a refractive index superior to that of the commonly used xylene-soluble media. The modified Faure solution dries rapidly without much contraction and the mounts can be kept for many years without sealing the coverglass. For giving the specimens the desired position two very fine insect needles should be used, but unnecessary manipulations which easily damage the tiny insects should be avoided. After the coverslip is applied a gentle touch with forceps will usually bring capsized specimens back into the right shape, but this procedure requires some experience. Colour patterns show extremely well under a stereomicroscope (dissecting type, 100x), with direct illumination from above, and as a background fine white drawing paper may be used. Some structural differences, such as length and distribution of bristles can be studied with the same type of microscope with transmitted light from a mirror, but finer structural details, such as the study of the crenulae, requires a good compound microscope with built-in phasecontrast equipment (magnification 400x, De Bach & Landi, 1960). The use of the stereomicroscope has the advantage that several specimens can be studied simultaneously, if the slides are placed one on top of the other.

Key for the Determination of the South African *Aphytis* Species and of some Imported Species to be released in South Africa

1. Cerci with three long subequal hairs and one short hair. General body colour pale yellow. Lateral margins of mesoscutum pronouncedly blackish. Eyes coarsely hairy. Each parapsis with three setea. Front wings with a distinct cloud beneath the stigma . . . . . **cercinus**

— Cerci with only two subequal hairs and one short hair. Lateral margins of mesoscutum not bordered 2

2. Funicle composed of only two small subequal segments, club short, two and one half times as long as broad. General body colour pale yellow to pallid with a few dark markings on the thoracic sterna. Posterior margin of scutellum and that of hind femora dusky. Front wings with a faint cloud beneath the stigma . . . . . **funicularis**

— Funicle consisting of two short segments and one long segment, club three times as long as broad or longer. Colour of body and of wings different 3

3. First segment of funicle in females rudimentary, much smaller than the second. Eyes coarsely hairy. Dark markings of body rather developed. Head with a narrow black bar on either side of the occiput. Propodeum with 1 + 3 hairs near the stigma. Sides of abdomen with five to six coarse dark setae marginally on segments III-VII. Pupa ventrally black (head, thorax, abdomen and appendages) . . . . . **chilensis**

— First segment of funicle usually not much if any smaller than the second segment (except for the males of *merceti*, where the first segment is absent and the second vestigial). Propodeum with 1 + 1 hairs near the stigma. Eyes finely hairy 4

4. Cranium with black bars and margins. Occiput with narrow black bars transversely on either side of the foramen, and black bars on the cheeks from the epistoma to the base of the eyes. Margins of foramen magnum and oral fossa more or less blackish. Body with blackish or brownish infuscations. Wings usually clouded below the stigma and the union of submarginal and marginal veins. Delta-area of frontwing with very many (more than 60) hairs, which are more densely placed than usual 5

— Cranium without black bars and margins. Wings usually almost completely hyaline. Delta-area with comparatively few hairs 8

5. Antennal club of female four times as long as wide, with about 20 rhinaria in females and about 30 rhinaria in males. Male antenna with two teeth at the middle of scape, funicle with the first segment missing and the second rudimentary. Triangular plates which suspend ovipositor prodigiously developed. Gonostyli very long, almost as long as mid-tibia. Body very strongly pigmented, thorax almost completely blackish-brown, bristles coarse. Mesoscutum with 20 or more setae. Front wings distinctly clouded beneath the stigma . . . . . **merceti**

— Antennal club of female less than four times as long as wide, with seven rhinaria in the females and three rhinaria in the males. Male antenna normal. Ovipositor skeleton not enlarged at base. Gonostyli about one-third as long as mid-tibia (*Proclia*-group). 6

6. Flagellum uniformly dark, but the club usually not blackish at the apex, or the tip of the latter only slightly more infuscated. Abdomen with dark spots and coarse setae on the sides, from three to 10 setae marginally on segments III-VII. Setae coarse. Crenulae large and strongly protruding. Mesoscutum and scutellum completely brownish, or nearly so, except for a pale longitudinal stripe down the middle. Mesoscutum with from 10-18 setae. Sometimes dark bands across the abdominal tergites. Front wings with a distinct cloud or band beneath the stigma and the union of the submarginal and marginal vein. Wings relatively wide, the longest fringe about one-seventh as long as the greatest width of the disc . . . . . **diaspidis**

— Flagellum brownish and the apex of the club black or the funicle or the club both pallid in parts. Abdomen less markedly pigmented, with from two to five hairs marginally on segments III-VII. Setae thin 7

7. Mesoscutum and scutellum with brown spots, the former with about 10-13 setae. Front wings almost banded across the disc below the stigma. Wings not much narrowed, the longest marginal fringe about one-fifth to one-sixth the greatest width of the disc . . . . . **maculicornis**

— Mesoscutum and scutellum less pigmented or with scarcely any brownish, the former with from 10-14 setae. Front wings weakly clouded beneath the stigma, somewhat narrowed, the longest marginal fringe from one-fourth to one-third of the greatest width of the disc . . . . . **hispanicus**

8. Body uniformly brownish-grey. Thoracic sterna strongly infuscated. Antennae brownish as well as tibiae. Mesoscutum with 10-14 setae. Antennal club of female about three times as long as wide. Crenulae well developed, but not overlapping. Ovipositor relatively small, gonostyli only about one-fourth as long as mid-tibia. Pupa ventrally black (head, thorax, abdomen and appendages) . . . . . **griseus**

— Body completely yellow to pallid with few if any dark markings. Gonostyli at least one-third as long as mid-tibia or longer. In some species the posterior margin of the scutellum may be dusky as well as the thoracic sterna. Front wings relatively wide, and mostly hyaline, except for a weak cloud which may be below the union of submarginal and marginal vein 9

9. Male antennal club covered with long hairs, their length exceeding the greatest width of the club. Propodeum with wide reticulation, crenulae few but well developed. Abdomen with two setae marginally on segments III-VII. Posterior margin of scutellum and thoracic sterna dusky as well as hind margin of hind femora. Front wings rather broad, slightly more than two times as long as wide, longest marginal fringe about one-fifth the greatest width of the disc . . . . . **ciliatus**

— Male antennal club normal, covered with short hairs only. Marginal fringe of front wing about one-sixth the greatest width of the disc 10

10. Antennal club of females less than three times as long as wide. Length of propodeum about one-fourth of its width. Crenulae very small and irregular. Mesoscutum with 12-14 hairs. Only the posterior margin of the scutellum dusky, ventral side of thorax not pigmented . . . . . **flavus**

— Antennal club of females plainly three times as long as wide or longer 11

11. Propodeum relatively short, its length slightly less than one-fourth of its width. Crenulae very small, almost invisible. Mesoscutum with 10 hairs. Posterior margin of scutellum and thoracic sterna dusky . . . . . **taylori**

— Length of propodeum one-fourth of its width or longer. Crenulae always well developed (*Chrysomphali*-group) 12

12. Body of adults without any dark markings, thoracic sterna immaculate, posterior margin of scutellum pale. Crenulae large, scalelike and overlapping 17

— Posterior margin of scutellum dark. Thoracic sterna dusky in adults, or at least a dark line on the mesosternum clearly developed 13

13. Pupa pale, without dark patches, or only with a Y-shaped mark on the mesosternum. Crenulae small and non-overlapping 16

— Pupa dark with well-defined pigmentation at least on the thoracic sterna and on the midventral abdominal plates. Crenulae large and overlapping (*Lingnanensis*-like forms) 14

14. Head of pupa pale or head darkening towards the end of the pupal stage when patches on thorax and abdomen are already deeply coloured. Gonostyli about half the length of mid-tibia. Breeds in *Aspidiotus hederae* and *Chrysomphalus dictyospermi* 15

— Head of pupa pale or head darkening at the beginning of the pupal stage when patches appear on the thorax while the abdomen is still predominantly pale. Abdomen of pupa deeply infuscated towards the end of the pupal period. Thoracic sterna of adults dusky in variable degree, usually only a Y-shaped mark visible. Antennae usually not much darkened. Gonostyli about one-third to one-half of the length of mid-tibia. Does not breed in *Aspidiotus hederae* or *Chrysomphalus dictyospermi*. Life-cycle at 80°F. in red scale 13½ days . . . . . **africanus**

15. Thoracic sterna of adults deeply infuscated. Antennae usually quite dusky. Life-cycle at 80°F. in red scale 12 days . . . . . **coheni**

— Thorax ventrally with a Y-shaped mark in the adults, otherwise infuscation weak. Antennae not much darkened. Life-cycle at 80°F. in red scale 13 days . . **lingnanensis**

16. Thoracic sterna of adults rather strongly infuscated. Female with three rhinaria on the third funicle joint and mostly with eight rhinaria on the club. Mesoscutum with 12-13 hairs. Breeds in *Lepidosaphes beckii*. Both sexes commonly found, reproduction biparental . . . . . **lepidosaphes**

— Thorax ventrally with a Y-shaped mark in the adults, otherwise infuscation weak. Female with one to two rhinaria on the third funicle joint and with five to six rhinaria on the club. Mesoscutum with about 10 hairs. Does not breed in *Lepidosaphes beckii*. Only females commonly found, reproduction uniparental . . . . . **chrysomphali**

17. Pupa pale, no black spots or marks on body whatsoever. Mesoscutum of adults with 10 hairs . . . . . **fisheri**

— Pupa with black spots at least on the thoracic sterna 18

18. Pupa rather pale, but with dark pigmentation on the thoracic sterna, more clearly defined towards the end of the stage, abdomen pale. Mesoscutum of adults with 10 setae . . . . . **melinus**

— Pupa rather dark, with dark patches on the thoracic sterna and on the abdomen, the head becoming somewhat infuscated towards the end of the pupal stage. Mesoscutum with 10-12 setae . . . . . **holoxanthus**

DESCRIPTION OF THE SPECIES

Aphytis cercinus Compere, 1955

Distinguishing characters: Each cercus with three long dark, subequal hairs and one short hair; submarginal vein with three large setae instead of the usual two setae.

FEMALE: Dorsum of head, thorax and abdomen yellow, grading to white on the sides and underparts. Lateral margins of mesoscutum pronouncedly blackish. Posterior margin of propodeum blackish between the spiracles. Legs yellow to white. Antennae largely yellow, the scape paler, and the apex of the club slightly dark. Front wings with a distinct cloud beneath the stigma. No infuscation beneath the union of the submarginal and marginal veins.

Pedicel one and one-half times as long as wide and plainly shorter than the third segment of the funicle. Club three times as long as wide. The eyes of this species seem to be slightly more coarsely hairy than in any other species except *chilensis* (Howard). Each parapsis with three setae instead of the usual two. Mesoscutum with 12 setae. Abdomen with three setae marginal from segment III-VII.

Length 0.8 mm.

The foregoing characterization is based on Compere's description. Compere described this species from 12 females from *Aspidiotus* species on mistletoe, Durban (Natal), 18. XII, 1925, reared by E. W. Rust.

Aphytis funicularis Compere, 1955, fig. 2 a-e.

Distinguishing characters: Funicle composed of two small subequal segments instead of the usual two short segments and one long segment. There may be a vestigial suture near the base of the club of the female; if complete this suture would make the antenna six-segmented.

FEMALE: General colour pale yellow to pallid with a few dark markings which consist of the blackened prosternum, mesothoracic furca and metasternum, and infuscations of the posterior margins of scutellum, propodeum and hind femora. Antennae faintly dusky. On the mesoscutum there are a number of setae of varying length.
There may be from 20-30 of such setae, but individuals with only seven setae have also been found. The parapsidal plates may bear two or three hairs. Crenulae small but distinct, about 5 + 5, dark and somewhat pointed, propodeum with fairly wide reticulation. Front wings with a dusky tinge beneath the stigma and at the beginning of the marginal vein, relatively wide, marginal fringe moderately short, the longest hairs scarcely more than one-eighth of the greatest width of the disc. Seven or eight rows of hairs present posterior to the speculum.

Length 0.7 mm, ovipositor in flattened position 0.3 mm.

MALE: In general appearance similar to the female except for primary sexual differences. The tip of the antennal club fairly blackish.

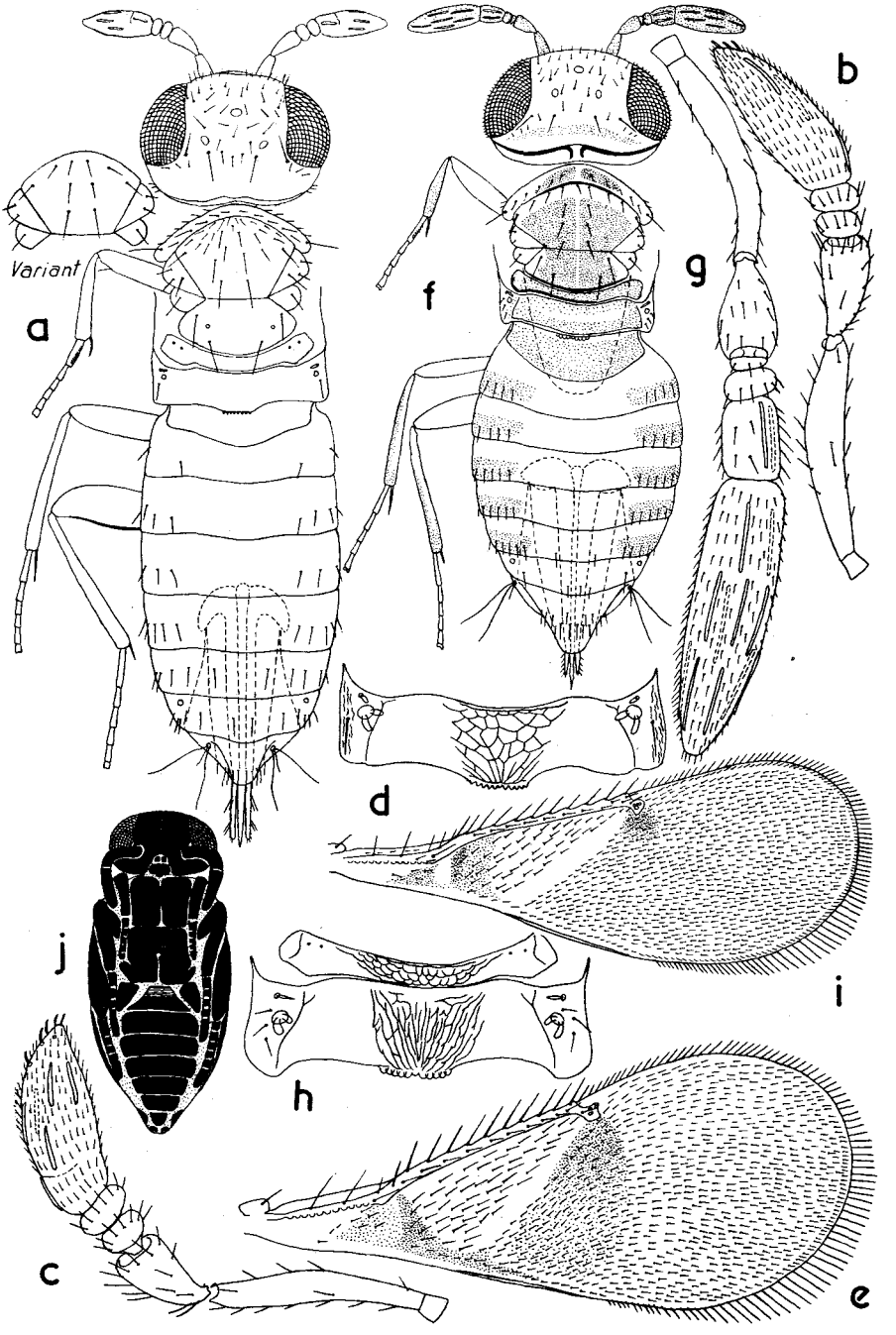
At hand are three slides with 16 females and two males collected from *Rolaspis chaetacmae* on *Cheaetacme aristata*, Durban (Natal), November 1962, J. Munting. The specimens agree well with what Compere has described as the African form of *Aphytis funicularis*.

Aphytis chilensis (Howard, 1900), fig. 2 f-j.

Distinguishing characters: First segment of funicle rudimentary, much smaller than the second. Eyes coarsely hairy, that is, the hairs apparent under relatively low magnification. Propodeum with three marginal hairs on either side below the spiracle, instead of the usual one hair.

EXPLANATIONS OF FIGURES

Fig. 2. *Aphytis funicularis* Compere: **a.** body of female, **b.** male antenna, **c.** female antenna, **d.** propodeum, **e.** front wing. *Aphytis chilensis* (Howard): **f.** body of female, **g.** female antenna, **h.** propodeum, **i.** forewing, **j.** pupa.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FEMALE: Yellow to white with dusky areas as follows: antennae except scape, whole mesoscutum and scutellum, except for a pale longitudinal stripe down the middle, margins of dorsal sclerites of thorax, lateral anterior margin of propodeum, anterior margin of petiole. Abdomen with lateral spots or weak bands across the dorsum. Front wings with a distinct cloud beneath the stigma and across the area beneath the union of the submarginal and marginal veins. Head with a narrow black cross bar on either side of the occiput, cheeks with narrow black lines.

Antennal club between three and four times as long as wide, with 11 rhinaria, and third funicle segment with two rhinaria. Mesoscutum with about 15 hairs. Sides of abdomen with four to six coarse dark setae marginal on each of the segments III-VII.

Length 0.9 mm, ovipositor in flattened position 0.3 mm. The pupa of *Aphytis chilensis* is almost completely black on the ventral side.

This cosmopolitan species is apparently uniparental. The two slides in the collection of the Biological Control Section, Pretoria, contain 10 females which were collected by the author from Ivy scale (*Aspidiotus hederae*) on rough lemons from a citrus orchard at Rosslyn, near Pretoria, 3. XI. 1961. Another female was collected from the same host on Ivy (*Hedera helix*) at Pretoria, 7.II.1961. The identification was kindly confirmed by H. Compere.

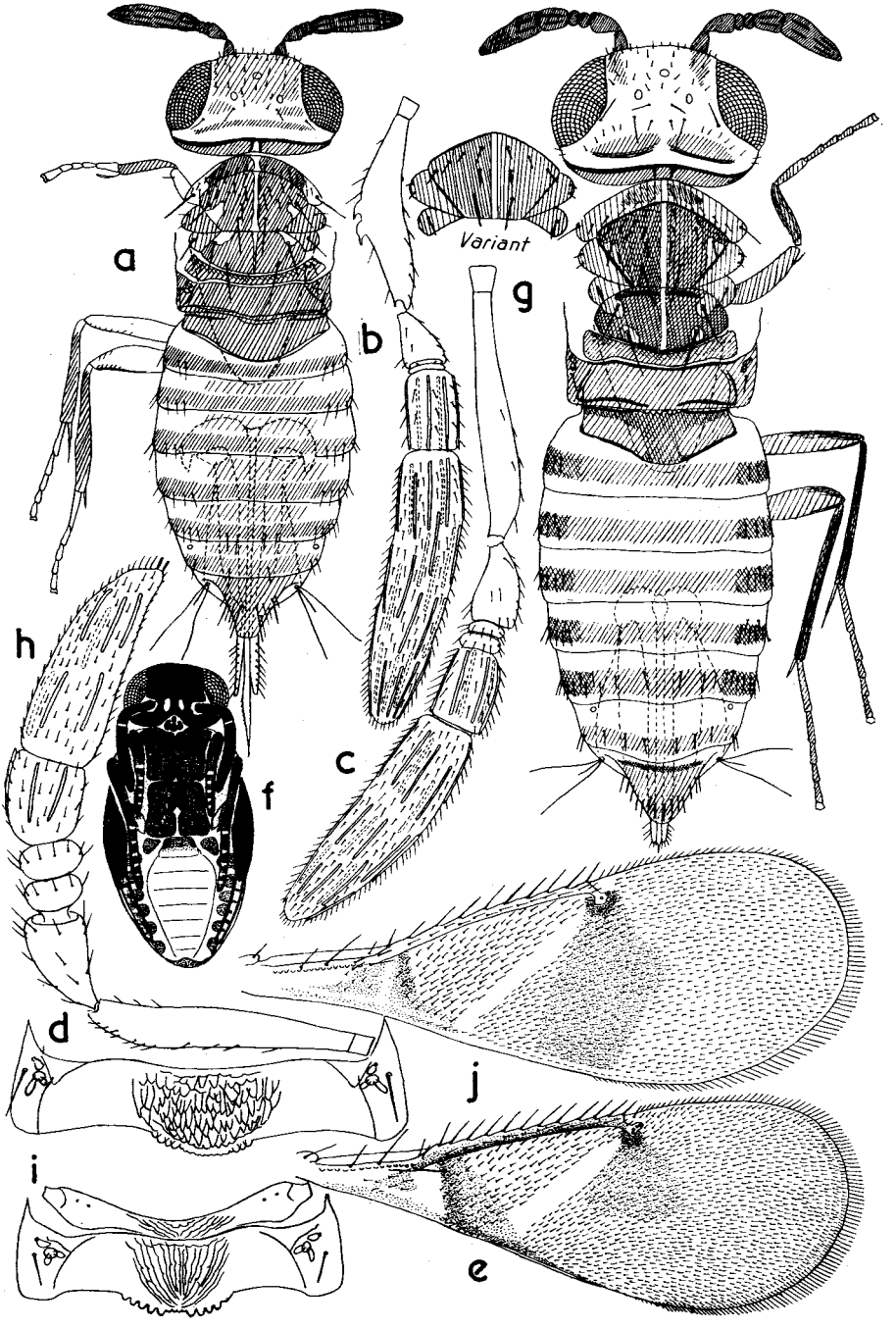
Aphytis merceti Compere, 1955, fig. 3 a-f.

Distinguishing characters: This is the largest, most coarsely setose and extensively blackish species of *Aphytis*. The plates that suspend the ovipositor are much larger, and the rhinaria on the antennal club appear in greater numbers than in any other species. The gonostyli are also very long, almost as long as the mid-tibia.

FEMALE: Yellow to white, extensively marked with brownish to blackish, as follows: antennae except scape, occiput on either side of foramen, whole mesoscutum and scutellum except for a pale longitudinal stripe down the middle, concealed parts of pronotum and mesoscutum, margins of dorsal sclerites of the thorax, lateral anterior margins of propodeum, anterior margin of petiole. Abdomen with dark bands across the dorsum, most pronounced on the third and ninth segments. Front wings with a cloud beneath stigma and across the disc beneath the union of the submarginal and marginal veins. Endoskeleton extensively blackish. Occiput and cheeks with narrow black bars as in the *proclia*-group.

EXPLANATIONS OF FIGURES

Fig. 3. *Aphytis merceti* Compere: **a.** body of female, **b.** male antenna, **c.** female antenna, **d.** propodeum, **e.** frontwing, **f.** pupa. *Aphytis diaspidis* (Howard): **g.** body of female, **h.** female antenna, **i.** propodeum, **j.** frontwing.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Antennal club between three and four times as long as wide, with about 20 rhinaria, and third funicle segment with about six rhinaria. Mesoscutum with about 20 setae of which four are large and coarse. Sides of abdomen with four to seven coarse dark setae on each of the segments III-VII.

Length 1.3 mm, ovipositor in flattened position 0.7 mm.

MALE: Antennae almost four-segmented, that is, first funicle segment missing and the second vestigial. Rhinaria numbering six on the third funicle segment and about 30 on the club. Otherwise similar to the female. Mr D. P. Annecke has found a rather unusual character on the male antenna which has been overlooked so far. There are two small, but distinctly protruding, pointed teeth in the middle of the posterior margin of the scape, a unique feature for *Aphytis*.

The pupa of *Aphytis merceti* is almost completely black on the ventral side, except for the abdominal mid-sterna, which are pale.

At hand are seven slides with seven females and 11 males collected by the author from *Lindingaspis rossi* on *Phoenix canariensis* at Pretoria, 20.II.1961, and three females and seven males collected from *Lindingaspis greeni* on *Chrysophyllum megaliesmontanum* at Bourke's Luck (Lydenburg Distr., Tvl.), in November 1961, Miss C. J. Cilliers. The determination was confirmed by H. Compere.

Aphytis diaspidis (Howard, 1880), fig. 3 g-j.

Distinguishing characters: A fairly large, coarsely setose and rather blackish species of *Aphytis*. Flagellum uniformly dark, club with seven rhinaria in the females. Mesoscutum on the average with 14 setae.

FEMALE: Yellow to white, extensively marked with brownish to blackish as follows: mesoscutum and scutellum completely brownish or nearly so, except for a pale longitudinal stripe down the middle. Abdomen with dark spots and coarse setae on the sides, and sometimes weak dark bands across the dorsum. Flagellum uniformly dark, but the club not blackish at the apex. In some specimens the tip of the club may be slightly more infuscated. Front wings with a distinct cloud beneath the stigma and the union of the submarginal and marginal vein, but the amount of pigment rather variable, sometimes the wing being almost hyaline. Endoskeleton extensively blackish. A narrow black bar on the occiput transversely on either side of foramen, and on the cheeks from the epistoma to the base of the eyes. More or less blackish or brownish are also the margin of the foramen magnum and parts of the ovipositor.

Antennal club about three times as long as wide, with seven rhinaria and third funicle segment with three to four rhinaria. Mesoscutum with from 10-18 setae. Sides of abdomen with three to 10 rather coarse, dark hairs marginally on segment III-VII. Crenulae long and protruding. Front wings relatively wide, the longest fringe about one-seventh as long as the greatest width of the disc. Delta-area with very many hairs (more than 60), which are placed almost as densely as the hairs on the disc.

Length 1.1 mm, ovipositor in flattened position 0.3 mm.

MALE: Colour less dark than in the female, otherwise about the same.

At hand are one slide with two females, collected from *Quadraspidiotus perniciosus* on plum at Franschhoek (C.P.) 25.IV.1961, J. H. Giliomee; two slides with 17 females and three males, collected from *Duplachionaspis sansevierae* on *Sanseviera* at Durban (Natal) in November 1962, J. Munting and one slide with five females, collected from *Quadraspidiotus perniciosus* on a pear tree at Pretoria, 24.II.1958, E. C. G. Bedford. Concerning some of this material H. Compere wrote to the author: "I cannot distinguish between the specimens that I call *diaspidis* and those you call *diaspidis*."

Aphytis maculicornis (Masi, 1911), fig. 4 a-e.

Distinguishing characters: A rather variable species, much like *diaspidis* but less blackish in colour, with fewer and finer setae. Mesoscutum with about 10-13 setae. Wings not much narrowed, the longest marginal fringe about one-fifth to one-sixth the greatest width of the disc. Flagellum brownish or pallid in parts, while the apex of the club is black.

FEMALE: Yellowish, extensively marked with brownish, but patches more diffuse than in *diaspidis*. Head as described for *diaspidis*. Antennae rarely more than three times as long as wide, all segments of funicle as well as the club dark, and the pedicel pallid in distinct contrast, or antennae uniformly brownish with only the tip of the club blackened. There is considerable variation of the amount of pigmentation present on the antennae, but in most cases the funicle and tip of the last segment seem to be deeper in colour than the basal part of the club. Front wings not much narrowed, the longest marginal fringe about one-fifth to one-sixth of the greatest width of the disc, more or less clouded beneath the stigma.

Length 1.0 mm, ovipositor in flattened position 0.3 mm.

MALE: Very much the same as the female, pigmentation less developed.

Available for study were specimens collected by D. P. Annecke from *Africaspis chionaspiformis* or *Melanaspis corticosa* (mixed colonies) at Ngwavuma (Natal) in September 1961 (one male and one female), from *Ledaspis distincta* on *Protea caffra* at Pretoria, in August 1961, (three females) and from a diaspine scale associated with *Chrysomphalus ficus* on Naartjies at Durban (Natal), in May 1961 (four females). Mr Compere's comments on the material sent to him by the author is as follows: "The specimens you call *maculicornis* differ in colour from those I call *maculicornis*. The pedicel and basal two-thirds of the club is pale in contrast to the remainder of the antennae which is dark in so-called typical *maculicornis*. This may be only a variation. Who knows? The variation seems endless."

Aphytis hispanicus (Mercet, 1912), fig. 4 f-h.

Distinguishing characters: The species considered here as *A. hispanicus* is almost identical with *A. maculicornis* except for the somewhat narrower front wing and its longer marginal fringe, and the coloration of the body which is only little infuscated on the thorax and abdomen.

FEMALE: Antenna with pedicel, funicle and club uniformly brownish except for the apex of the club which may be black. There are, however, individuals where the club seems to be rather uniformly brown. Front wings weakly clouded beneath the stigma and at the union of the submarginal and marginal vein, the longest marginal fringe from one-fourth to one-third of the greatest width of the disc. Mesoscutum with 10 to 14 setae. Antennal club less than three times as long as wide.

Length 0.9 mm, ovipositor in flattened position 0.3 mm.

At hand are two females collected from *Quadraspidiotus perniciosus* on pears at Pretoria, 24.II.1958, E. C. G. Bedford; two females from Mangoscale (*Aulacaspis cinnamomi*) at Nelspruit, in June 1962, K.E.G. Lambourne, and one female collected with *Rolaspis chaetachmae* at Durban (Natal), in November 1962, J. Munting.

Aphytis griseus spec. nov., fig. 5 a-e.

Distinguishing characters: This species is unique for its uniform greyish or brownish-grey pigmentation of the body, the rather elongate abdomen and the comparatively short ovipositor.
The gonostyli are rather short, measuring about one-fourth of the length of the middle tibia.

FEMALE: Greyish-yellow, all parts of the body more or less evenly tinged with light fuscous, but no well confined spots or black lines except for the posterior margin of the mesoscutum and an extensive darkening of the prosternum, the mid-thoracic furca including parts of the prepectus, and the metasternum. Occiput pale, but epistomal sutures and tips of mandibles blackish.

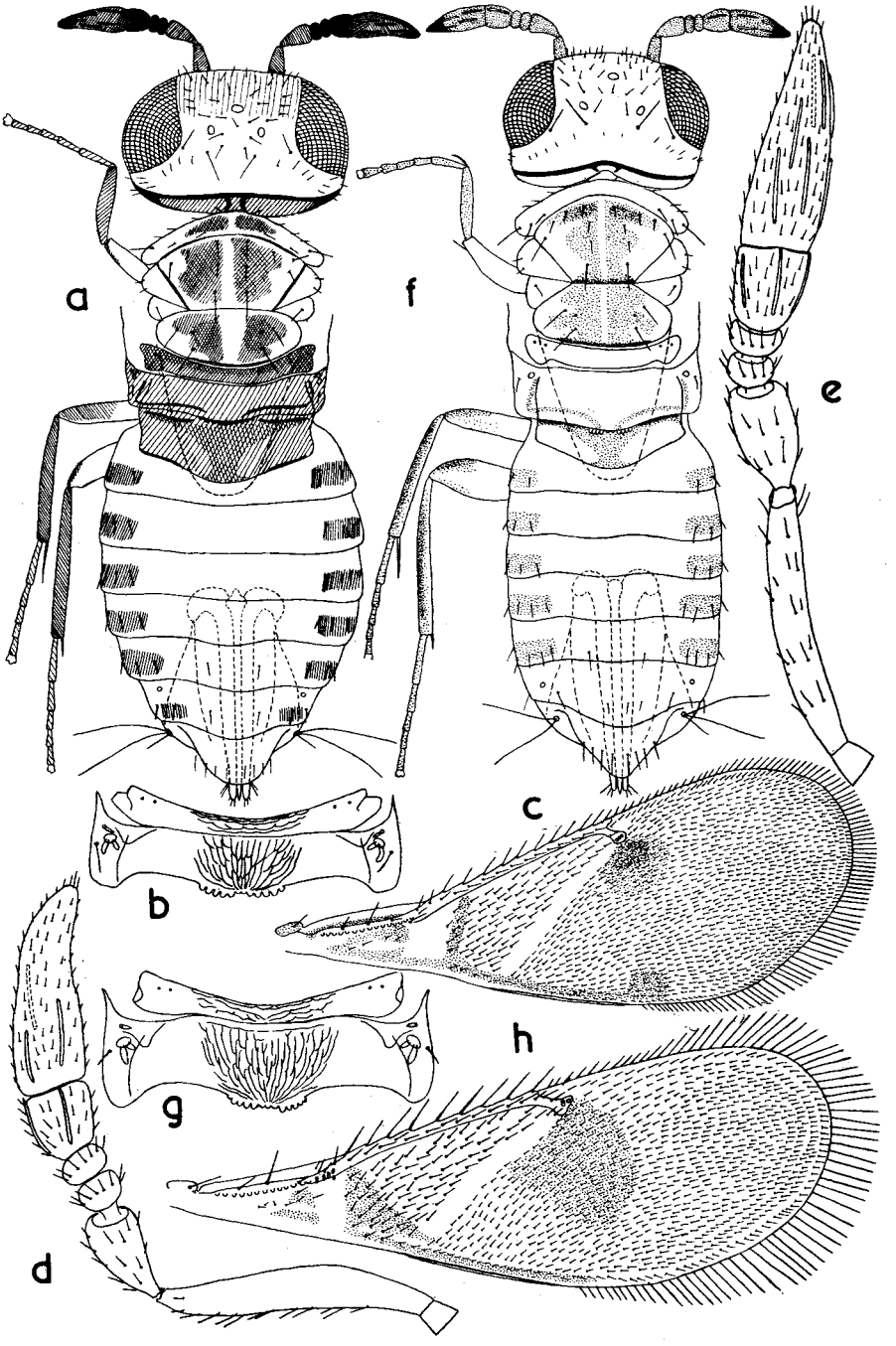
Antennae uniformly dusky, normally segmented. Club about three times as long as wide, with six rhinaria, third funicle segment usually with one rhinarium. Mesoscutum with approximately 10 rather coarse setae. Propodeum with fairly wide reticulation. Crenuale well developed. Sides of abdomen with from two to six dark hairs marginally on each of the segments III-VII.

Front wings almost completely hyaline, faintly dusky below the submarginal vein. About six rows of hairs basad of the speculum eight to 12 setae outside along the marginal vein. Marginal frinuge of disc about one-fourth to one-fifth as long as the greatest width of the disc.

Length 1.2 mm, ovipositor in flattened position 0.3 mm.

EXPLANATIONS OF FIGURES

Fig. 4. *Aphytis maculicornis* (Masi): **a.** body of female, **b.** propodeum, **c.** frontwing, **d.** male antenna, **e.** female antenna. *Aphytis hispanicus* (Mercet): **f.** body of female, **g.** propodeum, **h.** frontwing.


a
f
e
c
b
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d

MALE: Except for primary sexual differences similar to the female.

PUPA: Entirely black on the ventral side.

Described from 29 females and 30 males (all designated as syntypes) collected from *Nelaspis exalbida*, a white mussel scale on *Aloe arborescens* and *Aloe marlothii*, at Pretoria, 7.IV and 3.V.1961, and 20.II.1962, F. W. Quednau. Types are deposited at the collection of the Biological Control Section, Plant Protection Research Institute, Pretoria, and in the Department of Biological Control at Riverside (California), U.S.A.

Aphytis ciliatus spec. nov., fig. 5 f-i.

Distinguishing characters: The male of this species may be distinguished from the males of all other species by the presence of long hairs on the third funicle segment and the club.

MALE: General colour yellow with few dark markings consisting of the dusky colour of the prosternum, the mesothoracic furca, and the metasternum, and the blackening of the posterior margin of the scutellum and of the hind femora. Antennae fairly dusky. Mesoscutum with 10 hairs. Crenulae small, but distinct, 3 + 3, propodeum with fairly wide reticulation. Front wings fairly broad, two and two-third times as long as wide, hyaline except for a weak cloud at the union of submarginal and marginal vein. Longest marginal fringe about one-fifth the greatest width of the disc.

Length 0.5 mm.

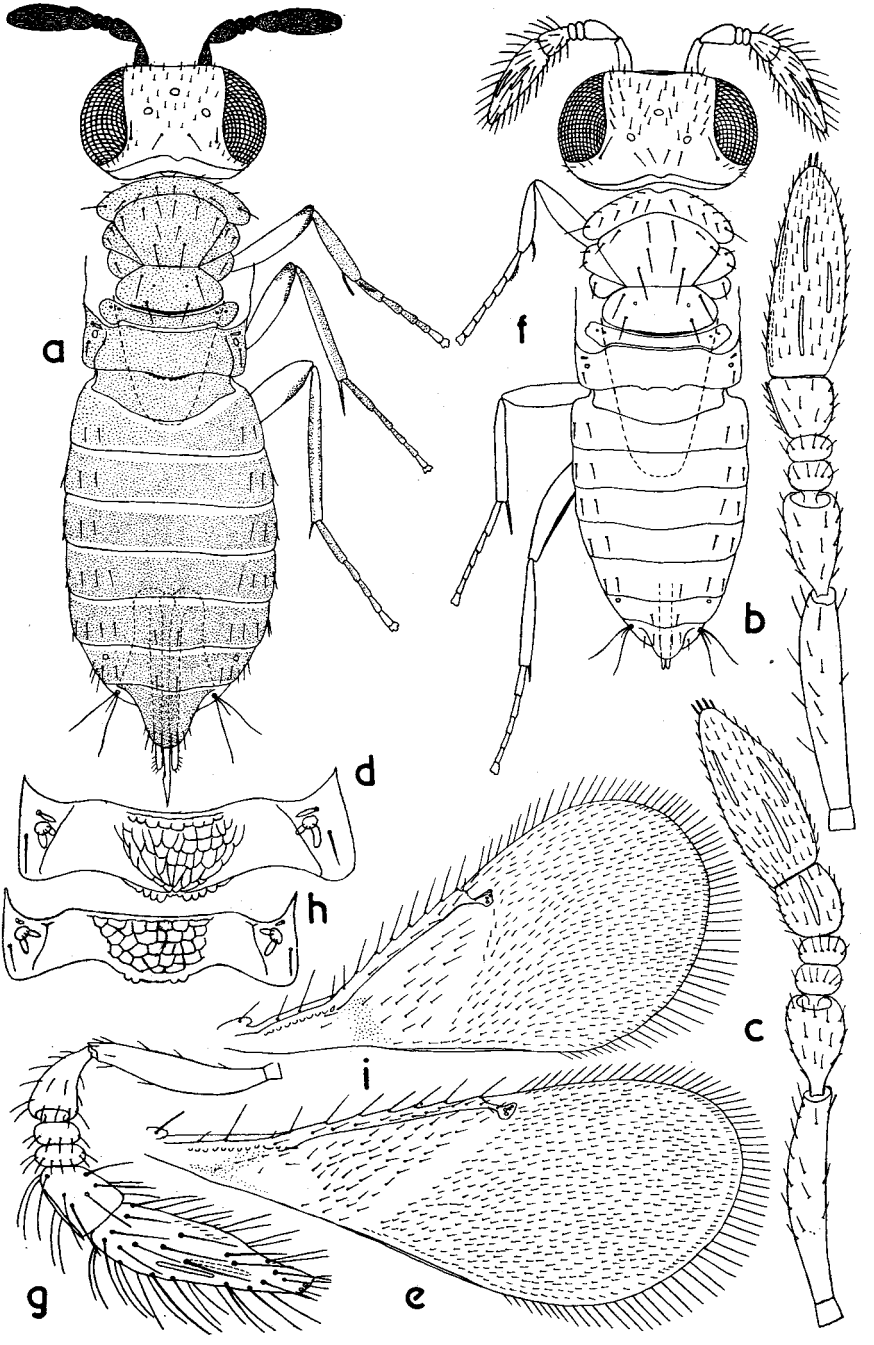
Described from ♂-holotype, associated with *Aphytis funicularis* from *Rolaspis chaetachmae* on *Chaetachme aristata* at Durban (Natal), November 1962, J. Munting. The type is deposited in the collection of the Biological Control Section, Plant Protection Research Institute, Pretoria.

Aphytis flavus spec. nov., fig. 6 a-e.

Distinguishing characters: Antennal club of female slightly less than three times as long as wide. Propodeum relatively short, reticulation cells longer than broad, crenulae very small and irregular. Mesoscutum with 12-14 hairs. Only the posterior margin of the scutellum dusky, otherwise ventral side of thorax in the adults not pigmented.

EXPLANATIONS OF FIGURES

Fig. 5. *Aphytis griseus* spec. nov.: **a.** body of female, **b.** female antenna, **c.** male antenna, **d.** propodeum, **e.** frontwing. *Aphytis ciliatus* spec. nov.: **f.** body of male. **g.** male antenna, **h.** propodeum, **i.** frontwing.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FEMALE: Completely pale yellow to pallid, dark markings only in form of the infuscated hind margin of the scutellum. Thoracic sterna pale. Front wings more or less completely hyaline. Longest marginal fringe about one-sixth of the greatest width of the disc. Mesoscutum with 12-14 hairs. There may be two or three parapsidal hairs. Abdomen with two to five setae marginally on segment III-VII.

Length 1.2 mm, ovipositor in flattened position 0.4 mm.

MALE: Very much the same as the female.

This species was first believed to be *Aphytis africanus*, but it can be clearly distinguished from that species by the very small crenulae and the absence of dark pigments on the ventral side of the thorax. Described from five females and three males (all designated as syntypes) which were collected together with *Aphytis funicularis* Comp. from *Rolaspis chaetachmae* on *Chaetachme aristata* at Durban (Natal), in November 1962, J. Munting. The types are deposited in the collection of the Biological Control Section, Plant Protection Research Institute, Pretoria.

Aphytis taylori spec. nov., fig. 6 f-j.

Distinguishing characters: Antennal club of female three times as long as wide. Propodeum short, its length less than one-fourth of its width, with narrow reticulation. Crenulae very small and almost invisible. Females with seven to eight rhinaria on the club. Posterior margin of scutellum dusky and thoracic sterna maculate. A biparental species.

FEMALE: Completely pale yellow to pallid with few dark markings, which consist of the infuscation of the posterior margin of the scutellum and of dusky areas at the prosternum, the thoracic furca including parts of the prepectus, and the metasternum. Front wings hyaline, except for a weak cloud below the submarginal vein, relatively wide and densely hairy. Marginal fringe short, its greatest length about one-sixth of the greatest width of the disc. About 12 setae along the outer margin of the marginal vein, these setae scarcely, if at all, larger than the coarse setae along the middle of the vein. Mesoscutum with 10 relatively short dark setae. Abdomen with two to five setae marginally on segment III-VII.

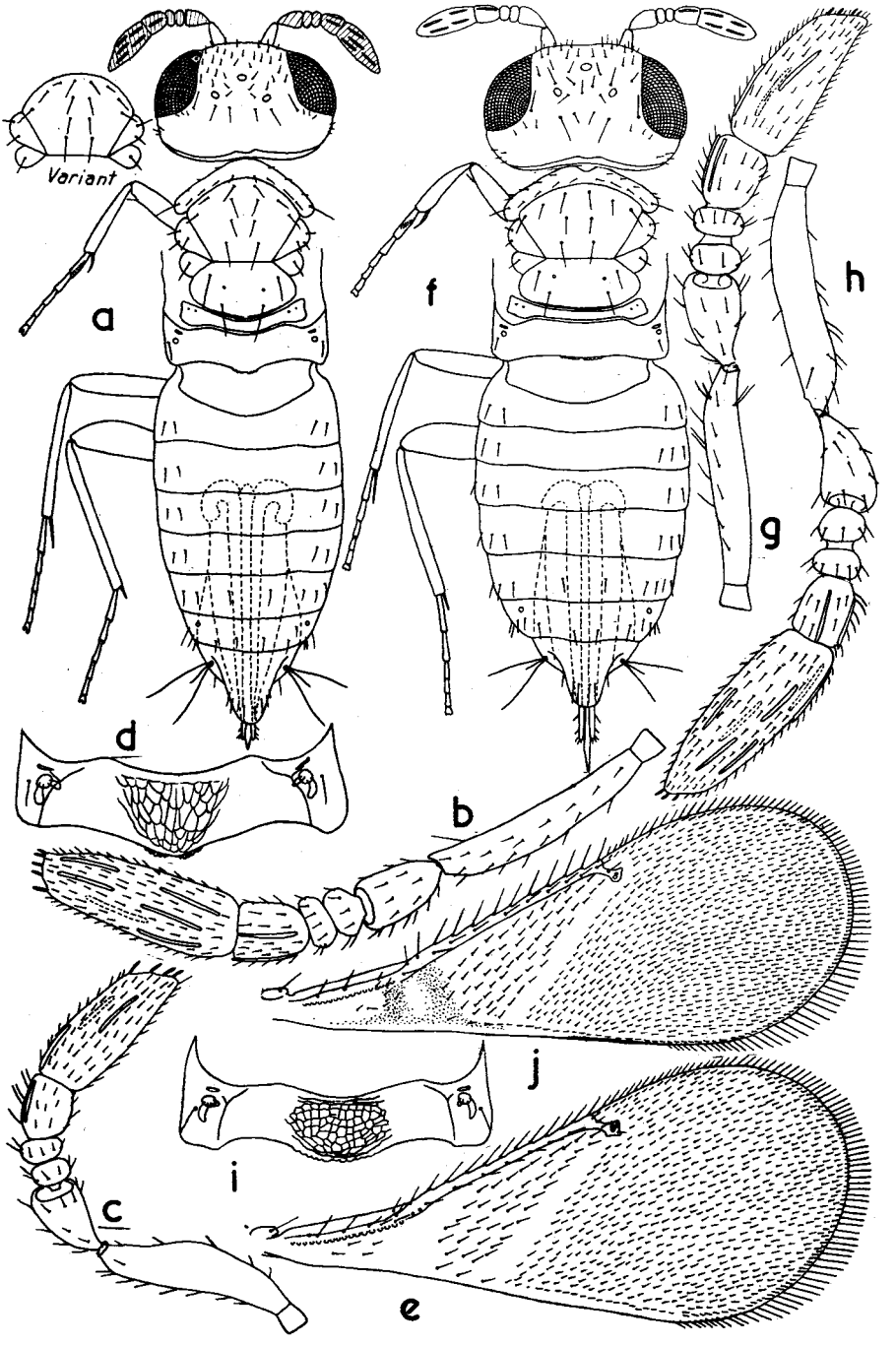
Length 1.1 mm, ovipositor in flattened position 0.4 mm.

MALE: Very much the same as the female.

This species was preliminarily identified by the author as *Aphytis mytilaspidis* (Le Baron, 1870), to which *A. taylori* has a superficial resemblance.

EXPLANATIONS OF FIGURES

Fig. 6. *Aphytis flavus* spec. nov.: **a.** body of female, **b.** female antenna, **c.** male antenna, **d.** propodeum, **e.** frontwing. *Aphytis taylori* spec. nov.: **f.** body of female, **g.** male antenna, **h.** female antenna, **i.** propodeum, **j.** frontwing.


Variant
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Through the kindness of Mr Compere slide material of *A. mytilaspidis* was made available for comparison. It is apparently unisexual, has completely pale thoracic sterna, although the hind margin of the scutellum is somewhat dusky, and the crenulae are larger and more developed, about as much as in *Aphytis chrysomphali* (Mercet). The gonostyli of *A. taylori* are longer (ratio length gonostylus to length mid-tibia 1:2) than in *A. mytilaspidis* (ratio length gonostylus to length mid-tibia 1:2.5). Available for study were five slides with 40 females and seven males (all designated as syntypes) ex *Aspidiotus capensis* on *Cycas* at Port Elizabeth, in February 1962, J. S. Taylor, for whom the new species is named. Types are deposited in the collection of the Biological Control Section, Plant Protection Research Institute, Pretoria.

A. chrysomphali-GROUP

The species of this group are not easy to differentiate. They all possess well developed but not always overlapping crenulae on the posterior margin of the fairly long (length one-fourth of greatest width) propodeum. There is also a fairly slender antennal club which is usually slightly but distinctly more than three times as long as wide. The front wings have not more than five or sometimes six oblique rows of hairs basad of the speculum. Head, thorax and abdomen are pale lemon yellow, except for some more or less developed infuscations on the thoracic sterna and a variable amount of blackish on the posterior margin of the scutellum which is to be seen in some of the species. *Aphytis fisheri* De Bach, *A. melinus* De Bach and *A. holoxanthus* De Bach show no dark marks on the body whatsoever except for a pair of black dots at the base of the front wings which are relatively wide. The marginal fringe is short, its greatest length about one-sixth of the greatest width of the disc. The wings are typically hyaline except for a faint to moderate infuscation below the union of the marginal and submarginal veins.

There is no doubt that the species of this group are very closely related, and for lack of sufficient morphological characters in the adults the pigment pattern of the pupae can be used for the differentiation with good results. Nevertheless some of the species listed here might rather be considered as subspecies by some systematists. As a rule, reciprocal cross-breeding tests have negative results, even with geographically defined races of the same species. There are also physiological criteria such as different host preferences and differences in the length of the life-cycles. With the exception of *Aphytis lepidosaphes* which so far as known is strictly monophagous on *Lepidosaphes beckii* (Mussel Scale), all other species attack several hosts of which Citrus Red Scale (*Aonidiella aurantii*) is the most important one.

There is little doubt that the colonization of some of the species of this group will result in an economic benefit for the citrus grower, as has been demonstrated in Israel and California. Attempts are being made to establish foreign species of the *chrysomphali* group also in South Africa. Therefore, the following descriptions also include species which have been introduced or which are to be introduced into this country.

Aphytis lepidosaphes Compere, 1955, figs 7 a-e, 8 n, o, p.

Distinguishing characters: This is a distinctive species. Antennal club of female with eight rhinaria and the first funicle segment with three rhinaria. Non-overlapping, small crenulae on the posterior margin of the propodeum. Thoracic sterna with plainly dusky areas at the prosternum, the thoracic furca including part of the prepectus and of the metasternum. Mesoscutum with 12 hairs. From two to seven abdominal setae marginally on each of the segments III-VII. Pupa yellowish, except for a Y-shaped mark on the mesosternum.

Length 1.0 mm, ovipositor in flattened position 0.4 mm.

A biparental species which is strongly host-specific. At hand are specimens reared from *Lepidosaphes beckii* on lemons at the Citrus Experiment Station Insectary, Riverside (California), December 1959. The original breeding stock was obtained from Mussel scale on oranges, collected at Lo-Kong-Tung, near Katon (China) by J. L. Gressitt and Y. W. Djou, November 1948.

This species is on the importation list of the Biological Control Section, Plant Protection Research Institute, Pretoria. The material examined originated from Mussel scale on lemons, collected at the Citrus Experiment Station Insectary, Riverside (California), in December 1959, S. Warner coll. and De Bach det.

Aphytis lingnanensis Compere, 1955, figs. 7 l, 8 f, g, l, m.

Distinguishing characters: Females with five to six rhinaria on the club and with two to three rhinaria on the third funicle segment. Large overlapping scale-like crenulations on the posterior margin of the propodeum.
Thoracic sterna less dusky, usually only a Y-shaped mark present. Mesoscutum with 11-12 hairs. Abdominal setae from two to six marginally on each of the segments III-VII. Ratio length gonostylus to length mid-tibia 1:2 to 1:2.4. Pupa with sternal and midabdominal plates extensively blackish, the head becoming dark towards the end of the pupal period, virtually identical with the pupa of *A. holoxanthus* and *A. coheni.*

Length 1.1 mm, ovipositor in flattened position 0.4 mm.

A biparental species. Hosts: *Hemiberlesea lataniae, Aspidiotus camelliae, Aonidiella aurantii, Aspidiotus hederae, Chrysomphalus dictyospermi* and young males of *Chrysomphalus ficus.* The specimens available for study were reared on Ivy scale and Red scale, at the Citrus Experimental Station, Riverside (California), U.S.A.

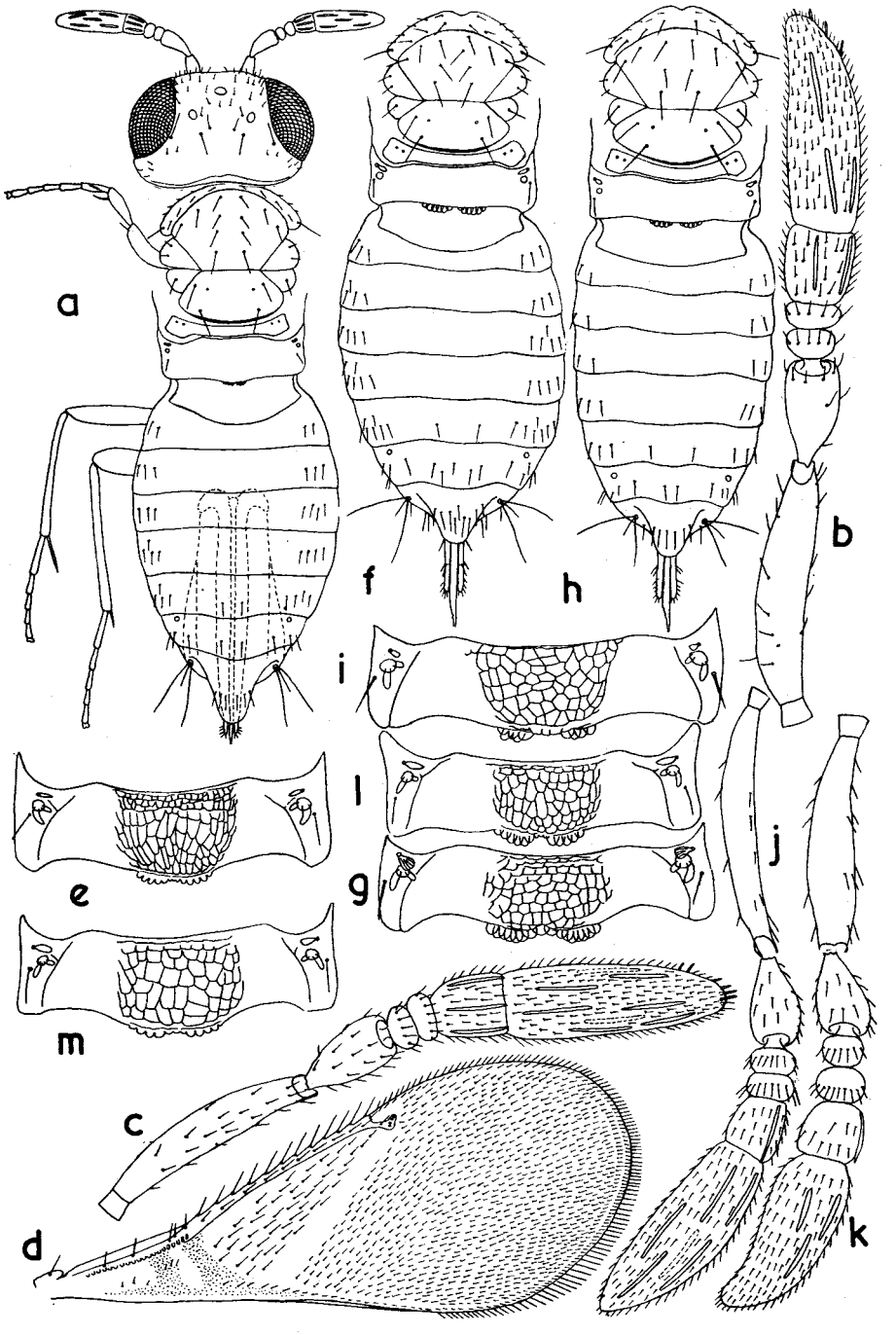
This species, formerly known as *Aphytis* "A", traces back to parents imported into California from South China in November, 1947. The shipment was made by J. L. Gressitt. A number of biological forms of *A. lingnanensis* seems to exist, especially one form from Khuti, India. According to De Bach (1959), this "khunti" *lingnanensis* fails to produce fertile crossings with typical *lingnanensis* from China, Hawaii or Mexico (which cross freely with each other), and also differs from typical *lingnanensis* in various biological aspects. This form is being colonized on Red scale in citrus orchards of Southern California.

TABLE I. Morphological characters of the species of the *Aphytis chrysomphali*-group.

	Rhinaria of female (funicle/club)	Ventral coloration of pupa	Development of crenulae	Coloration of sternal plates in adults
A. lepidosaphes	3/8	pale yellow, Y-shaped mark on mesosternum	small, non-overlapping	dusky areas at prosternum and mesosternum
A. lingnanensis	2/5 (1/5) or 2/6 (1/6)	thorax and abdomen black, head becoming infuscated towards the end of the pupal stage	large and overlapping	only mesosternal furca marked black
A. coheni				dusky areas at prosternum and mesosternum
A. africanus		head and thorax black, abdomen becoming infuscated at the end of the pupal stage		dusky areas variable but always present
A. chrysomphali		pale yellow, Y-shaped mark on mesosternum	small, non-overlapping	only mesosternal furca marked black
A. fisheri		pale yellow	large and overlapping	entirely pale
A. melinus		thorax black, head and abdomen pale		
A. holoxanthus		thorax and abdomen black, head becoming dark at the end of the pupal stage		

EXPLANATIONS OF FIGURES

Fig. 7. *Aphytis lepidosaphes* Compere: **a.** body of female, **b.** male antenna, **c.** female antenna, **d.** forewing, **e.** propodeum. *Aphytis coheni* De Bach: **f.** dorsal view of female body, variant with many setae, **g.** propodeum. *Aphytis africanus* spec. nov. **h.** dorsal view of female body, variant with few setae, **i.** propodeum, **j.** female antenna, **k.** male antenna. *Aphytis lingnanensis* Compere: **l.** propodeum. *Aphytis chrysomphali* (Mercet): **m.** propodeum.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The material examined was designated as *Aphytis lingnanensis* Compere, "khunti" strain, which was collected at the Citrus Experiment Station Insectary, Riverside (California), 23.XI.1959, ex Ivy and Red scale, S. Warner coll. and De Bach det.

Aphytis lingnanensis was received by the Biological Control Section of the Plant Protection Research Institute, Pretoria, in March 1963. This species seems to be one of the most efficient natural enemies of *Aonidiella aurantii*. Its fecundity and host mutilation action is higher than that of any other species of the *chrysomphali*-group (Quednau, in press).

Aphytis coheni De Bach, 1960, figs. 7 f, g, 8 n, o, q, r.

Distinguishing characters: This species is very similar to the foregoing but can be easily separated by the more intensive blackening of the thoracic sterna. In the adults the posterior margin of the propodeum bears at least seven large overlapping crenulae on each side. Antennae quite dusky when cleared. Dusky areas on the mesosternum more pronounced than in *A. lingnanensis*. Mesoscutum with 11-12 hairs. Pupa indistinguishable from that of *A. lingnanensis*.

Aphytis coheni, in contrast to *A. lingnanensis* and *A. africanus*, has a rather short life-cycle which is about 12 days in Red scale at 80°F.

Length 1.1 mm, ovipositor in flattened position 0.4 mm.

A biparental species. Hosts: *Aonidiella citrina*, *Aonidiella aurantii*, *Aspidiotus hederae*, *Chrysomphalus dictyospermi* and *Chrysomphalus ficus* (only males suitable for development). Importation into South Africa was made in November 1962. Available for study were slides containing specimens of both sexes which emerged from Ivy scale on potatoes at the laboratory of the Biological Control Section, Pretoria, collected in November, 1962.

Aphytis coheni was first received in the insectary of the Department of Biological Control at Riverside (California) on 19th January, 1960. These shipments contained parasitized *Aonidiella aurantii* collected from citrus trees at Ashke-

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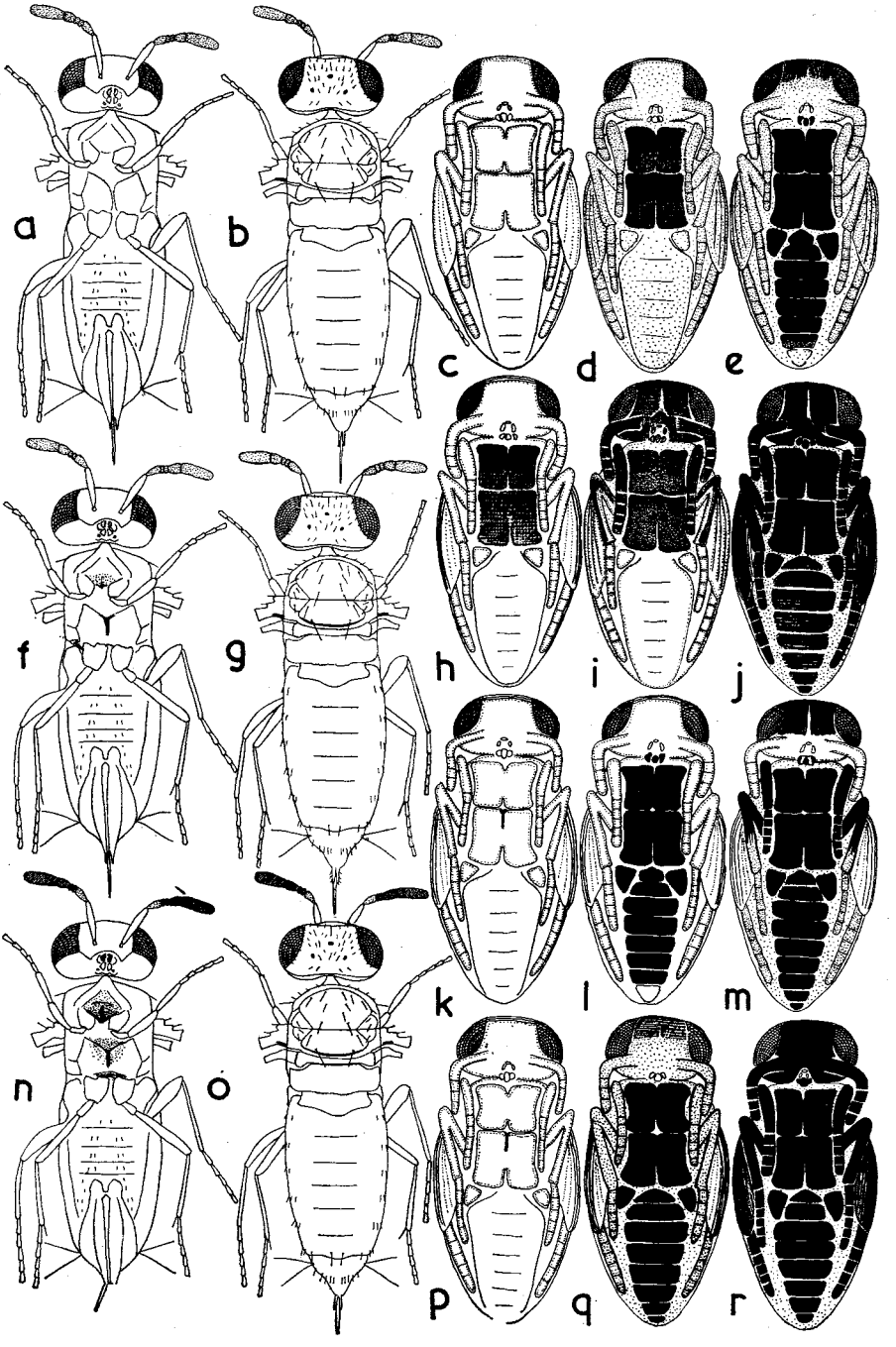
EXPLANATIONS OF FIGURES

Fig. 8. **a.** Ventral, **b.** dorsal view of female body as typical for *Aphytis fisheri* De Bach, *A. melinus* De Bach, and *A. holoxanthus* De Bach. **c-e.** pupae: **c.** *A. fisheri* De Bach, **d.** *A. melinus* De Bach, **e.** *A. holoxanthus* De Bach. - **f.** Ventral, **g.** dorsal view of female body as typical for *A. chrysomphali* (Mercet), *A. africanus* spec. nov., and *A. lingnanensis* Compere. **h-m.** pupae: **h.** and **i.** *A. africanus* spec. nov., young forms, **j.** same, old form. **k.** *A. chrysomphali* (Mercet), **l.** *A. lingnanensis* Compere, young form, **m.** same, old form. **n.** Ventral, **o.** dorsal view of female body as typical for *A. lepidosaphes* Compere, and *A. coheni* De Bach. **p-r.** pupae: **p.** *A. lepidosaphes* Compere, **q.** *A. coheni* De Bach, young form, **r.** same, old form.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lon (Israel) by David Nadel. *Aphytis coheni* was colonized on and recorded from Red scale in the field in Southern California. It was also released in South Africa near Addo (C.P.) and at Nelspruit (Tvl.), from where it has been recovered on several occasions subsequently.

Aphytis africanus spec. nov., figs. 7 h-k, 8 f-j.

Distinghuising characters: Very similar to *A. lingnanensis* and *A. coheni*. However in *A. africanus* the head of the pupa begins to darken already at the beginning of the pupal stage when the thorax is just dusky and the abdomen still pale. The older pupae are completely dark as in *A. coheni*. Crenulae protruding and overlapping, about 5 + 5, somewhat more irregular than in *A. lingnanensis*. Abdominal hairs very variable, two to three or three to seven setae present on each of the abdominal segments III-VII marginally. Thoracic sterna dusky, but to a lesser extent than in *A. coheni*, sometimes only a dark Y-shaped mark between the mesosternal plates present. Posterior margin of the scutellum infuscated. Mesoscutum with 10-11 hairs. Antennae only slightly darkened. Gonostyli relatively short, in individuals reared from red scale there is a ratio length gonostylis to length mid-tibia 1:2.8 to 1:3. Otherwise morphologically almost identical with *A. lingnanensis*.

The life-cycle of *A. africanus* in Red scale at 80° F. is longer than that of *A. coheni*, namely 13½ days.

Length 0.9 mm, ovipositor in flattened position 0.2 mm.

A biparental species, males like females in colour. Hosts: *Aonidiella aurantii*, *Chrysomphalus dictyospermi* and *Chrysomphalus ficus* (only males suitable for development). *Aphytis africanus* does not breed in Ivy scale (*Aspidiotus hederae*) and also not in *Chrysomphalus dictyospermi*, which separates it biologically from *A. lingnanensis* and *A. coheni*. Ecotypes or biological forms of this species have been collected from *Lindingaspis rossi* on *Phoenix canariensis* and from *Furcaspis capensis* on *Aloe*, both at Pretoria, January and February 1961. Records of this species are also available from *Fulaspis karroo* on *Acacia karroo*, Pienaarspoort (Tvl.), from *Duplachionaspis sansevierae* on *Sanseviera*, Durban (Natal) and from *Pseudaulacaspis pentagona* on mulberry, Pretoria. These ecotypes have somewhat more infuscated sterna and slightly longer gonostyli, especially those from *Furcaspis capensis*. Description of species made from 35 females and 31 males (all designated as syntypes) reared from *Aonidiella aurantii* on oranges collected at Letaba (Tvl.), 26.V.1961 and 1.X.1962. This species seems to be indigenous to South Africa. At hand are many samples from the Transvaal (Letaba, Tzaneen, Limburg, Rustenburg, Nelspruit, Zebediela), Natal (Muden, Weenen) and the Cape Province (Addo, Citrusdal). Types are deposited in the collections of the Biological Control Section, Plant Protection Research Institute, Pretoria, and of the Department of Biological Control, Riverside (California), U.S.A.

Aphytis africanus was formerly considered to be the biparental form of *Aphytis chrysomphali* (Mercet), as occurring in the citrus orchards of South Africa

and Southern Rhodesia. Indeed the adult females of *A. africanus* are hardly distinguishable from *A. chrysomphali* unless the structure of the crenulae and the length of the gonostyli are examined. From laboratory tests it has been established that *A. africanus* does not breed in Ivy scale (*Aspidiotus hederae*), while *A. chrysomphali* does to some extent.

A shipment of *A. africanus* collected from *Aonidiella aurantii* on citrus trees in Rustenburg (Tvl.), was sent by the author to California, and was received in March 1961 at the insectary in Riverside. From this material limited numbers were propagated and colonized in the field on California red scale. No attempts to recover the species have been made (De Bach & Landi, 1962). In a letter to the author, Dr De Bach says that "*africanus* is difficult to distinguish from *lingnanensis*." However in a recent issue of the California Citrograph, De Bach & Landi (1962) have already recognized the biparental South African *Aphytis* from Red scale as a new species, and refer to it using the name *Aphytis* n. sp. (*africanus*, ms. name). Since Dr De Bach is still somewhat hesitant to describe the species formally, the author has given the description of *A. africanus* in this paper, in order to establish its name for future investigations.

Aphytis chrysomphali (Mercet. 1912), figs. 7 m, 8 f, g, k.

Distinguishing characters: Antennal club of female with five to six rhinaria, third funicle segment with one to two rhinaria. Non-overlapping small crenulae on the posterior margin of propodeum. Thoracic infuscation comparatively poorly developed, only a Y-shaped mark between the mesosternum. Posterior margin of scutellum blackish. Mesoscutum with 10 hairs. Abdominal setae variable, from two to three or three to seven hairs marginally on each of the segments III-VII. Pupa entirely yellowish, except for a Y-shaped mark on the mesosternum.

Length 0.8 mm, ovipositor in flattened position 0.3 mm.

Male exceedingly rare. The author has seen very few males occasionally occurring in laboratory cultures on Ivy scale. Reproduction uniparental.

Examination of the species made from slides with material reared from *Aonidiella aurantii* on oranges, collected at Addo (C.P.), 31.V.1961, W. Hanekom and from material reared from Red scale on Valencia oranges of Sinalva Ranch (Southern California), 25.I.1960, P. De Bach.

This species was originally described from the Balearic Islands and Spain, but it seems now to be fairly widely distributed (also California). In Southern Africa it is so far known to occur only in the Sundays River Valley, near Addo (C.P.). It was most likely introduced from the Mediterraneans when citrus was first introduced to the Cape Colony. Host species are: *Aonidiella aurantii*, *Aonidiella citrina*, *Chrysomphalus dictyospermi*, *Chrysomphalus ficus* (only the males suitable for development), and *Adpidiotus hederae*. *A. chrysomphali* breeds rather poorly, and mass cultures, even on Red scale are not easy to maintain. The optimum temperature for *A. chrysomphali* is lower than that for *A. africanus*.

Unfortunately the author was not able to study live specimens of *Aphytis chrysomphali* from California. As indicated by E. B. White (personal communication) laboratory technician of the Riverside Insectary, "*Aphytis lingnanensis* has replaced *chrysomphali* throughout its range to a substantial degree", and is now apparently difficult to find. He also wrote: "Interestingly enough, your comments concerning your '*chrysomphali*' describe our species very accurately in every respect."

Aphytis fisheri De Bach, 1959, fig. 8 a, b, c.

Distinguishing characters: This species somewhat resembles *A. lingnanensis* for its well developed and overlapping crenulae, but is easily distinguished by the lack of any dark pigments in the adult female body (except for two small dark spots at the base of the forewings), and by the completely yellowish pupa, which is without blackish sternal plates, lines or furca. Other characters suggestive of *Aphytis chrysomphali.* Mesoscutum with 10 hairs. Abdominal setae from two to four marginally on segments III-VII. Antennal club of female with five to six rhinaria, third funicle segment with one to two rhinaria.

Length 1.1 mm, ovipositor in flattened position 0.4 mm.

This is a biparental species and the males are common.

Examination of the species was made from slide material reared from Red scale on squash at the Citrus Experiment Station, Riverside (California), 1.XII.1959, S. Warner. Hosts: *Aonidiella aurantii, Aspidiotus hederae.*

Aphytis fisheri was first discovered by De Bach in the field on 21st-22nd, December, 1956, on *Aonidiella aurantii* on pummelo and rose at Kalaw and Taunggyi, (South Shan States), Burma. A shipment sent to Riverside (California), was successfully cultured by T. W. Fisher, after whom the species was named. Some field recoveries have been made in California.

Aphytis fisheri is one of a number of Red scale parasites to be imported into South Africa.

Aphytis melinus De Bach, 1959, fig. 8 a, b, d.

Distinguishing characters: Adults virtually identical with those of *A. fisheri*, but pupae with black pigmented thoracic sternal plates, especially towards the end of the pupal stage. Head and abdomen, also in the older pupae, pale. Body of adults without fuscous areas or furcal pigmentation. Ten setae on mesosternum. Posterior margin of propodeum with large overlapping crenulae.

Length: 1.0 mm, ovipositor in flattened position 0.4 mm.

This is a biparental species and males are commonly found.

Examination of the species made from slide material, reared from Ivy scale on squash at the laboratory of the Biological Control Section, Pretoria, 1.IX.1962. The introduction of the species was made from California to South Africa on 1st August, 1962.

Hosts: *Aonidiella aurantii, Chrysomphalus dictyospermi, Chrysomphalus ficus* (only males suitable for development), and *Aspidiotus hederae,* (in California also *Aonidiella citrina*). This species is also a very efficient parasite of Red scale.

Aphytis melinus was first received by the Department of Biological Control at Riverside (California), on 12th September, 1956, from *Aonidiella aurantii* collected by G. W. Angalet on rose at New Delhi, India. Other shipments were obtained from Lahore, Pakistan, Gurgaon, India, and Said-pur Village (near Rawalpindi), West Pakistan. *A. melinus* became well established in Southern California, where it successfully competes with and even replaces *A. chrysomphali* and *A. lingnanensis.*

Aphytis holoxanthus De Bach, 1960, fig. 8 a, b, e.

Distinguishing characters: Adults very similar to *Aphytis fisheri* and *A. melinus,* but pupae with a dark pigmented pattern on both the ventral side of the thorax and the abdominal mid-sterna, much like *A. lingnanensis* but perhaps with less pigment towards the tip of the abdomen. The head may become dark at the end of the pupal stage. Body of adult female wholly yellowish, no fuscous areas or furcal pigmentation. 10-12 dark setae on the mesoscutum. Posterior margin of propodeum with six to seven large overlapping crenulae on each side.

Length 1.0 mm, ovipositor in flattened position 0.4 mm.

This is a biparental species, the males being common.

Examination of the species made from slide material reared from Ivy scale on Kaffir watermelon at Pretoria Laboratory, on 15th September, 1962. The introduction of the species was made from California to South Africa on 17th February, 1962. Hosts: *Aonidiella aurantii, Aonidiella citrina, Chrysomphalus dictyospermi, Chrysomphalus ficus* (both sexes suitable for development), and *Aspidiotus hederae.* This is the only species of *Aphytis* which may possibly control Circular purple scale (*Chrysomphalus ficus*), since it is able to oviposit in both young and producing females of this scale.

Releases of *A. holoxanthus* were made in 1962 and 1963 in the Rustenburg and Nelspruit areas (Transvaal), where circular purple scale is fairly common. Recoveries were made in the Transvaal, and it seems that the parasites became established there.

Aphytis holoxanthus was first received in the insectary of the Department of Biological Control at Riverside (California), on 16th July, 1959, forwarded by D. W. Jones of U. S. Department of Agriculture, Parasite Introduction Laboratory at Moorestown (New Jersey). Jones had received material earlier in 1959 through the cooperation of I. Cohen and D. Nadel of the Citrus Marketing Board in Israel. Their original material was received in February, 1956 from S. K. Cheng in Hong Kong, where it was obtained from *Chrysomphalus ficus.* In Israel *Aphytis holoxanthus* was released and colonized in large numbers and succeeded in economically suppressing Circular purple scale in Israel citrus orchards (personal communication by D. P. Annecke, Pretoria, and Dr O. P. Schoeman, Zebediela).

SUMMARY

An account is given of the South African fauna of the aphelinid genus *Aphytis*, the species of which are considered to be among the most efficient natural enemies of diaspine scale pests. Included are a number of species which will be introduced into South Africa for the biological control of scale insects in citrus orchards, as well as five species described as new (*A. griseus*, *A. ciliatus*, *A. flavus*, *A. taylori* and *A. africanus*). A key is given for the identification of 19 species, which are also described in detail and illustrated.

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