

TWO FORMS OF *ANOPHELES PHILIPPINENSIS* IN MALAYA

By. J. A. Reid¹

Abstract: In Malaya 2 sibling species have been confused under the name *Anopheles philippinensis*. They are best distinguished by differences in the pupae and males. One species appears to be *A. philippinensis* Ludlow, the other is *A. nivipes* Theobald, long regarded as a synonym of *philippinensis*. Larvae of the 2 species often occur in the same breeding place. The possible distribution of these two outside Malaya and the problem of distinguishing them from *A. pallidus* are briefly discussed.

While examining pupae of SE Asian species of *Anopheles* of the Neocellia series (subgenus *Cellia*), such as *stephensi*, *maculatus*, *ramsayi*, *philippinensis* and *annularis*, it was noticed that Malayan pupae of *philippinensis* seemed to occur in two forms that differed mainly in certain characters of the paddle. On following this up it seemed clear that two very closely related species were being confused under the name *philippinensis*. The principal differences between these Malayan specimens of the two species are summarized in the TABLE; one species is identified as *A. philippinensis* Ludlow, 1902 and the other as *A. nivipes* Theobald, 1903.

There were 15 pupal skins of *philippinensis* and 22 of *nivipes*, all with matching larval skins and most with matching adult skins. They came from nine different breeding places widely distributed in western Malaya from Perlis in the north to Negri Sembilan in the south. In three places both species were present.

CHARACTERS

Pupae

In the characters of the pupal paddle (FIG. 1) there was little or no overlap between the two species (see TABLE), though a small degree of overlap may be found when larger numbers are examined. Length of the paddle hair is the unstraightened length measured with an ocular micrometer. Similarly, length of the refractile border is the direct length, not that measured along the curve.

All pupae could be clearly assigned to one form or the other on the characters of the paddle, but there were also other lesser differences. In pupae of *nivipes* the average number of branches on several of the abdominal hairs was a little higher than in *philippinensis*, as on hairs 2,VII and 9,VIII (setal numbers of Belkin 1962). A further slight difference is in the shape of the clypeus which tends to

TABLE. Comparison of Malayan specimens of *A. philippinensis* and *A. nivipes*. (Figures in brackets or to the right of oblique lines are the number of observations; immediately below those are averages.)

Character	<i>philippinensis</i>	<i>nivipes</i>
<i>Pupae</i>		
Paddle:		
No. of fringe teeth*	0-8 (22) 4.4	10-20 (24) 15.6
Length of refractile border/length of paddle	0.71-0.84 (15) 0.79	0.86-0.95 (22) 0.92
Length of paddle hair/length of paddle	0.27-0.39 (14) 0.31	0.12-0.27 (22) 0.21
Abdominal hairs, no. branches on:		
2,VII	1-3 (22) 1.9	1-5 (28) 3.1
9,VIII (last lateral spine)	8-12 (20) 9.5	10-16 (24) 12.6
<i>Males</i>		
Scales on center of sternite VIII	all white, 11/11	dark median, 15/16
Psd on vein 1 reaching Hd on costa	0/11	15/17
<i>Larvae</i>		
Palmate hair IV or V:		
Pigmentation of ends of blades	mottled 13/15	uniform 20/22
length of filament/length of blade	0.22-0.82**(17) 0.40	0.33-0.69 (22) 0.51
Head hairs, no. branches on:		
Posterior clypeal	4-11 (34) 6.8	4-10 (46) 6.4
Sutural (inner occipital)	3-7 (37) 4.8	4-10 (47) 7.3
Trans-sutural	5-8 (34) 6.4	5-11 (47) 7.7
Head hairs; sum of both suturals plus both trans-suturals minus sum of both posterior clypeals		
	1-16 (11) 9.1	11-26 (18) 18.1

* Fringe teeth occupy distal part of refractile border of paddle and are somewhat intermediate in character between teeth and fringe hairs, having a refractile and moderately thick basal half and non-refractile filamentous distal half.

** There was only one specimen with the high figure of .82 (next highest was .54) without this the average was .37.

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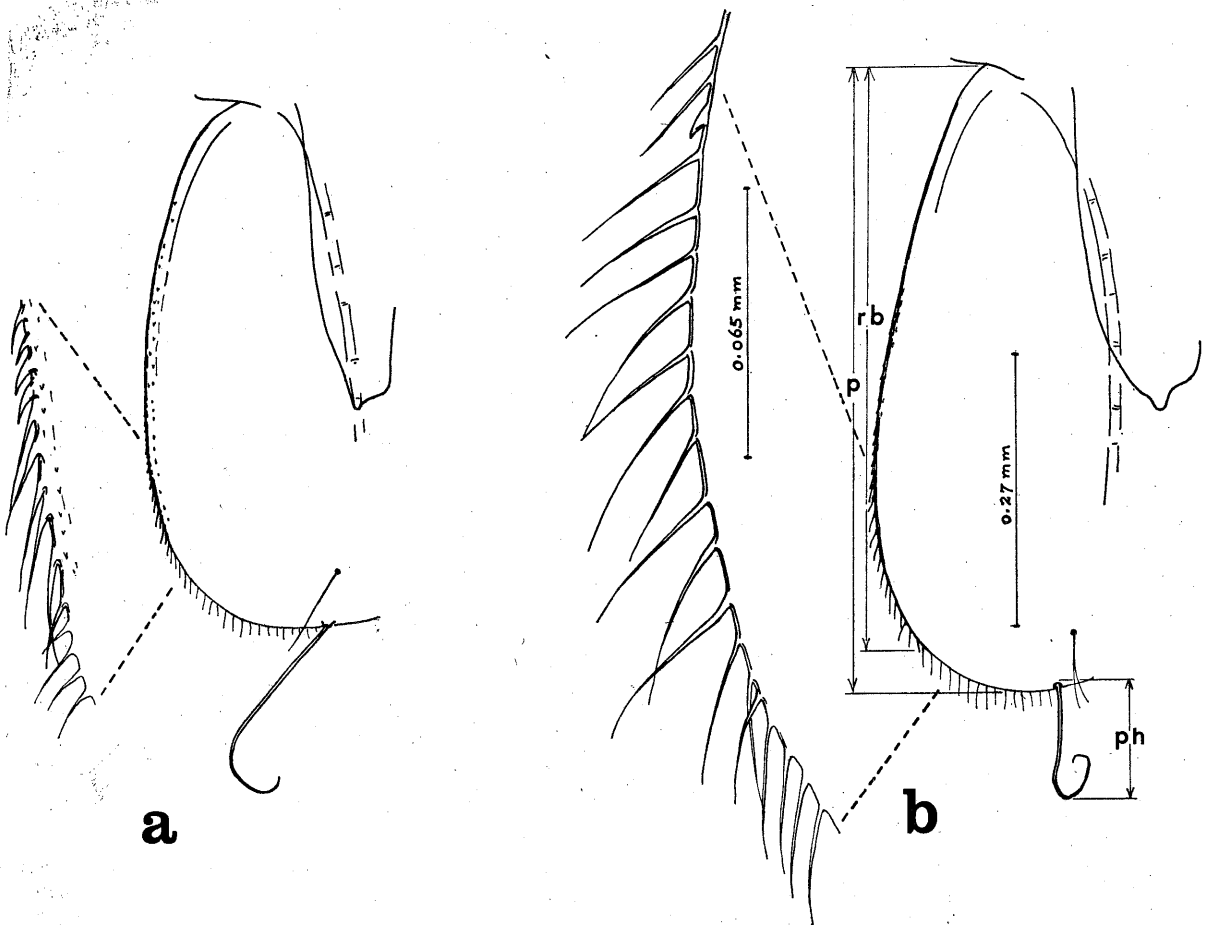


FIG. 1. Left paddle of male pupa, and part of external border of paddle enlarged; a, *philippinensis*; b, *nivipes*; p, paddle length; ph, paddle hair length; rb, refractile border length.

be more square-cornered in *philippinensis* than in *nivipes*, but there is overlap in this character.

Adults

The difference between adult males of the two species in the scale pattern on sternite VIII (dorsal after the normal rotation of the genitalia) is clear and easily appreciated in most specimens (FIG. 2), and there appears to be very little overlap. Wing difference also is easily appreciated when clear cut (see Colless 1948, fig. 18a for *philippinensis*, and Stanton 1926, p. 73 for *nivipes*), but in a proportion of specimens the presector dark mark (Psd) on vein 1 may just reach back to the level of the distal end of the humeral dark mark (Hd) on the costa of one wing and just fail to reach it on the other. Such specimens could not be identified on this character alone, and for this reason a proportion of females cannot be identified at present.

There does not seem to be any difference in the scale pattern of the end of the female abdomen corresponding to that in the males. However, there is a tendency for females of *nivipes* to have

rather more broad pale ventral scales than *philippinensis*, usually extending forward at least to sternite VI. No other useful external differences have been found in the adults.

The genitalia of two males of each species were compared. No differences were found in the phallosome leaflets which numbered 6–8 per side and were very much as illustrated by Christophers (1933) and Russell & Baisas (1936). Nor was there any difference in the number of setae on the harpago; however, there was a slight difference in the position of the most dorsal seta on the ventral lobe of the harpago. This seta, which lies between the large apical one and the club on the dorsal lobe, was external to the apical seta in both specimens of *philippinensis*, as illustrated for Philippine specimens by Russell & Baisas, but was directly in front of or slightly median to the apical seta in both specimens of *nivipes*.

Larvae

These show no differences that do not have some overlap, or at least none has been found. How-

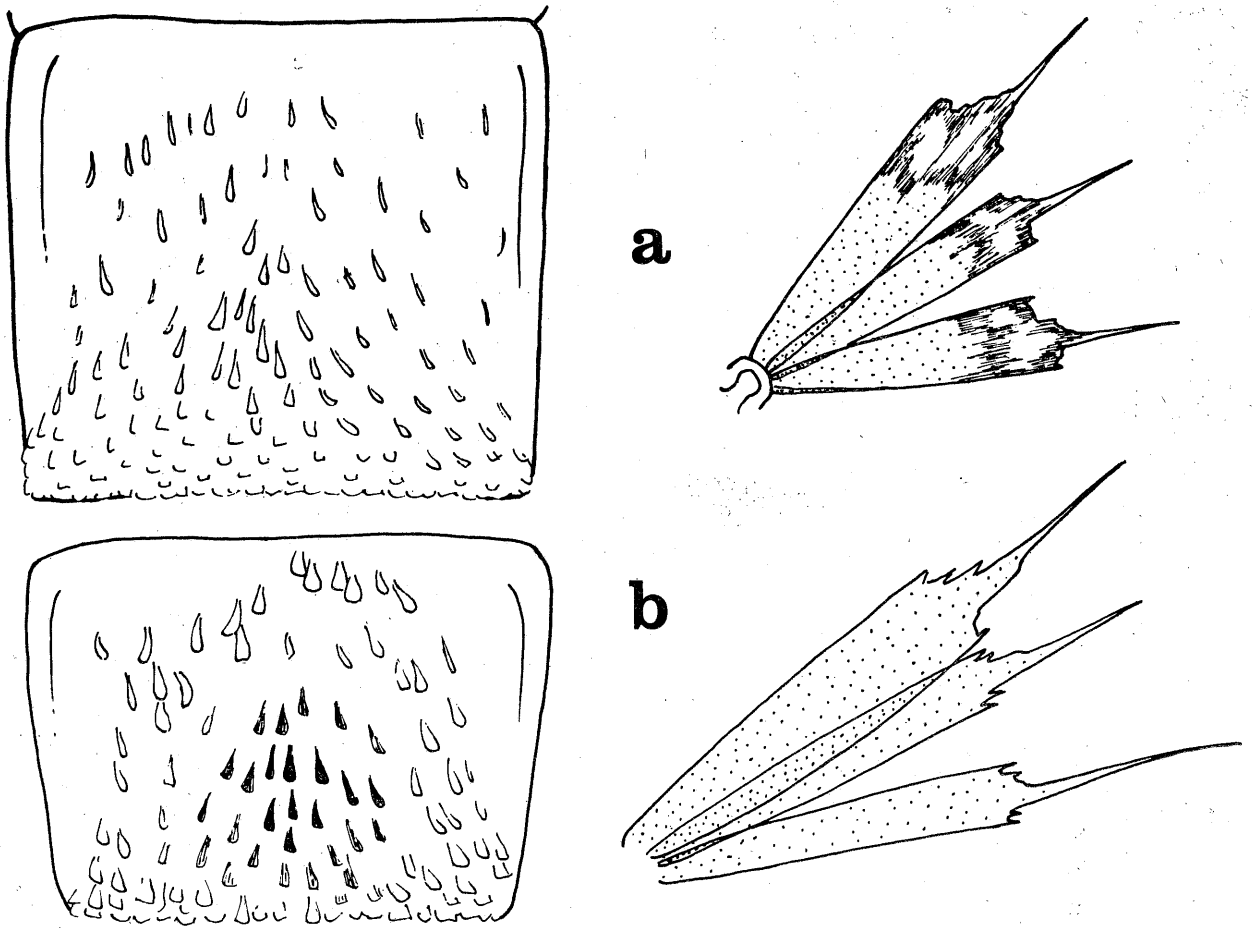


FIG. 2. Scales on sternite VIII of adult male, and leaflets from fourth abdominal palmate hair of larva; a, *philippinensis*; b, *nivipes*.

ever, a high proportion can be identified by a combination of the small differences summarized in the TABLE. In larvae of *philippinensis* the abdominal palmate hairs usually show a slightly mottled pattern of dark-rimmed paper areas towards the ends of the blades (FIG. 2), and the filaments, measured from the most basal notch, though of variable length, are commonly about 1/3 as long as the blades. In *nivipes* the blades are usually uniformly lightly pigmented and the filaments are commonly about 1/2 as long as the blades. The appearance of the palmate hairs should identify about 2/3 of the larvae, taking as *philippinensis* only those which have a mottled distal pattern on the blades and filaments less than half the blade length (see also Puri 1931), and taking as *nivipes* only those in which the blades are uniformly lightly pigmented and the filaments are half or more the blade length. On these criteria 24/37 or 65% of the larvae in these samples could be identified.

In *philippinensis* the sutural hair of the head, and also the trans-sutural, average fewer bran-

ches than in *nivipes*, but the posterior clypeal hair averages slightly more. This can be used by the summation method to identify about 2/3 of the larvae as follows: Among the 29 larvae to which the method could be applied, 18 were identified, and 11 were not because they had sums falling in the overlap zone 11-16. But of these 11 two more could be identified as *nivipes*, because they had sums for the number of branches on the four sutural and trans-sutural hairs in excess of 28, the range of this sum for *philippinensis* being 17-28 and for *nivipes* 22-37. So a total of 20/29 or 69% was identified by the summation method.

The appearance of the palmate hairs will confirm many identifications reached by the summation method; or vice versa, if preferred, since the summation method is a little laborious and requires specimens with all six relevant hairs intact. By a combination of both methods more than 4/5 of the larvae should be identifiable. For example, of the 9/29 larvae not identified by the summation method 4 or 5 more could be identified by the palmate

hairs giving a total of 24 or 25/29 (83% or 86%). Further confirmation of identifications made in this way would sometimes be given by the pigmentation of the inner shoulder hairs, usually paler in *philippinensis* and darker in *nivipes*. In the Philippines this character, in a more pronounced form, distinguishes larvae of *philippinensis* (pale) from those of *annularis* (dark) (Russell & Baisas 1934).

Couplet

The following couplet should serve to identify the majority of Malayan specimens. (Because of geographic variation and possible confusion with *A. pallidus*, it might not be reliable outside Malaya).

1. *Adult*: wing with presector dark mark on vein 1 not usually reaching back to distal end of humeral dark mark on costa; male with scales on center of sternite VIII all pale. *Pupa*: paddle with less than 10 fringe teeth and shorter refractile border, but a longer terminal hair about 1/3 length of paddle. *Larva*: blades of palmate hairs often with mottled distal pattern and filaments about 1/3 as long as blades; sum of branches on both sutural plus both trans-sutural hairs minus sum of both posterior clypeal hairs usually less than 15 **philippinensis**
2. *Adult*: wing with presector dark mark on vein 1 usually reaching or overlapping distal end of humeral dark mark on costa, male with median patch of dark scales surrounded by pale scales on sternite VIII. *Pupa*: paddle with 10 or more fringe teeth and longer refractile border, but smaller terminal hair about 1/4 or less as long as paddle. *Larva*: blades of palmate hairs usually uniformly lightly pigmented and filaments about 1/2 as long as blades; sum of branches on both sutural plus both trans-sutural hairs minus sum of both posterior clypeals usually 15 or more **nivipes**

NOTES

Status

There seems no reason to doubt that these two sympatric forms are species, although this should be confirmed by examining series of progeny reared from single females. Each such series should contain only one form or the other, not both or intermediates as would be expected if the two forms were polymorphs of a single species. The rearing of progeny series would also give an opportunity to examine the eggs for differences. The existing illu-

strations of eggs from India (Roy & Siddons 1939), Indonesia (Walch & Walch-Sorgdrager 1935) and the Philippines (Urbino 1936) appear to be very much the same, but these could all be illustrations of *philippinensis*. Christophers & Barraud (1931) thought they had two types of *philippinensis* eggs, one as illustrated by the workers quoted above, but the other like the egg of *A. maculatus*.

Names

The Malayan form here identified as *philippinensis* has been compared with specimens from the Philippines with matching skins. Though differing in some respects from the Philippine type form, probably due to geographic variation, the Malayan form agrees with the type form in the important characters of the pupal paddle and in the all-pale scales on sternite VIII of the male. Other points of resemblance are the shorter presector dark mark on vein 1, though this is more pronounced in the type form; the external position of the most dorsal seta on the ventral lobe of the harpago; and, in the larva, the appearance of the palmate hairs, the tendency to have a low number of branches on the sutural hair, and the pale inner shoulder hair.

The other Malayan form is readily identified by comparison with Theobald's types of *nivipes* from Kuala Lumpur, Malaya. The holotype male and a second male clearly show the median patch of dark scales on sternite VIII, and the presector dark mark on vein 1 reaching the humeral dark mark on the costa. The third specimen, a female, has Psd on vein 1 clearly overlapping Hd on the costa. All three specimens bear the same collection data and are undoubtedly those that Theobald described, although he recorded all three as males, and Christophers (1924) listed all three as females.

Distribution and geographic variation

Lack of reared specimens with matching skins and possible confusion with *A. pallidus* makes it impossible to determine the distribution of the two species outside Malaya with any certainty at present. However, it seems probable that *philippinensis* ranges from India to the Philippines. The type form is found in north Borneo as well as the Philippines. As pointed out by Colless (1948) it differs a little from Malayan and other mainland specimens in having a distinctly lower number of branches (2-4) on the posterior clypeal hair of the larva and in the usually paler wing to which Covell (1948) drew attention. Probably these differences are those of geographic variation. At any rate, there is insufficient evidence at present to warrant treating the mainland form, which is itself variable, as a distinct species from the Philippine type form, and

at this stage a subspecific name would only be a nuisance.

Larvae of the Malayan form seem to differ a little from those commonly encountered in such parts of India as lower Bengal where the sutural hairs are said to have not more than four branches (Puri 1931, Iyengar 1929). No specimens from lower Bengal have been seen by the writer, but from the descriptions of the sutural and palmate hairs they are presumably *philippinensis*. Gater (1934) noted the discrepancy between the number of branches on the sutural hairs described for Indian larvae and the number he found on Malayan larvae, though these will have included *nivipes*.

A few males and larvae that appear to be *philippinensis* have been seen from Indo-China (Tonkin, Toumanoff), Thailand, and Burma (no larvae). The latter includes some collected at Bhamo by Feegrade who found this species infected with malaria parasites. It has also been found infected at a number of places in lower Bengal, but was not found infected in Tonkin by Toumanoff (Covell 1944).

A. nivipes has been positively identified from Burma (Shwe Nyaung, Shan States, P.F. Mattingly, Dec. 1962, 1♂ with pupal and larval skins) and S Thailand (Trang Province, E.I. Coher & P.F. Beales, Sept. 1960, 1♀ with pupal and larval skins). Other males and larvae which appear to be this species have been seen from N Thailand (Chiengmai Province), and a few males that may be this species have been seen from Burma and Assam. The existence of *nivipes* in Assam could explain the difficulty encountered there in distinguishing larvae of "*philippinensis*" (which is not a malaria vector in Assam, Covell 1944) from those of *pallidus* (Chowdhury 1928, Masters 1948). In lower Bengal where there is not the same difficulty, *nivipes* may well be scarce or absent (compare *A. sinensis* which is present in Assam, but does not reach further west into the plains of India).

The question of differentiating *pallidus* from *philippinensis* and *nivipes* needs fresh study as the characters available at present are unsatisfactory (Reid 1963). The range of *pallidus* is uncertain, especially its eastern limits, and the pupae need to be compared with those of the other two species; this will be done as soon as suitable material is available. The few males of *pallidus* that have been seen had the scales on sternite VIII all pale as in *philippinensis*, but the presector dark mark on vein 1 was variable in length.

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revisional work for a book on the anopheline mosquitoes of Malaya and Borneo now nearing completion. I am very grateful to the Wellcome Trust for financial help and the British Museum (Natural History) for continuing to give me working space and other facilities. I would like to thank my colleagues W.H. Cheong, Senior Entomologist, and A. Ganapathipillai of the Institute for Medical Research, Malaya, for sending additional Malayan specimens; also Dr Alan Stone and Maj. John Scanlon at the U.S. National Museum, Washington, for the loan of Philippine specimens, and Prof. D.S. Bertram and his staff at the London School of Hygiene and Tropical Medicine for allowing me to study their collections.

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EPIZOOTIOLOGY OF *TRYPANOSOMA CRUZI* IN SOUTHWESTERN NORTH AMERICA

Part X: The Biosystematics of *Dipetalogaster maximus* in Mexico¹ (Hemiptera: Reduviidae) (Kinetoplastida: Trypanosomidae)

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Abstract: A review of the literature of *Dipetalogaster maximus* was made concerning the ecology, distribution, systematics and infection rates with *Trypanosoma cruzi*. New information is given concerning the ecology, life history, hybridizations, and laboratory infections of this large kissing bug.

Dipetalogaster maximus has been found to inhabit the crevices in exfoliative rocks in Baja California Sur and to feed on lizards. This species is quite fecund in the laboratory; one colony produced 434.5 eggs per ♀. Fed first instar nymphs lived up to 8 months without a blood meal; a well nourished specimen lived over 595 days. Specimens of *Dipetalogaster maximus* were infected with *T. cruzi* isolated from *Triatoma rubida* (Uhler), *T. peninsularis* Usinger, and *T. sinaloensis* Ryckman.

Dipetalogaster maximus (Uhler) was described *Conorhinus maximus* Uhler, 1894; the genus *Dipetalogaster* was proposed by Usinger (1939). *Dipetalogaster* has remained a monotypic genus since its original description; the species *maximus* is also monotypic, and it is quite likely that this situation will not change. This morphologically largest kissing bug probably has the smallest geographic distribution of any species of Triatominae; *D. maximus* is restricted to a relatively few square kilometers of rather specialized habitat at the southern tip of the peninsula of Baja California Sur, Mexico.

References concerned with the systematics of the species *maximus* in the genera *Conorhinus*, *Triatoma*, *Eutriatoma*, and *Dipetalogaster* may be found in the works published by Uhler (1894:286-87), Lethierry & Severin (1896:116), Fracker (1912:231), Neiva (1914a:48, 1914b:333), Del Ponte (1921:178-79), Larrousse (1924:207-10), Pinto (1925), Readio (1927:116-17), Del Ponte (1930:909-10, 917),

Pinto (1931:92), Neiva & Lent (1936:172), Usinger (1939:40-41, 1940), Neiva & Lent (1941:70, 79, 91, 92), Usinger (1944:13, 16, 41-42), and Wygodzinsky (1949:71).

DISTRIBUTION AND ECOLOGY

Dipetalogaster maximus is restricted in its distribution to the mountainous and hilly terrain of the Sierra de la Victoria and Sierra de la Trinidad at the southern end of the peninsula of Baja California Sur. These mountain ranges are completely isolated from the Sierra de la Giganta to the north by a low, sandy plain extending from LaPaz Bay on the east side of the peninsula to the Pacific Ocean to the southwest (FIG. 1). This species appears to occur only in exfoliative rocks and large boulder piles. Hence, it is restricted to the tropical, arid cape region of the peninsula and probably has not crossed the low, sandy plains to the west. During the Pleistocene this plain probably was covered by the Pacific Ocean making an island of the cape region and the Sierra de la Victoria (Nelson 1921, Shepard 1950). More efforts should be made to collect *D. maximus* to the northwest in the Sierra de la Giganta to determine if indeed its range is as circumscribed as present information would indicate. We have searched for *D. maximus* in the mountains northwest of the plains near La Paz but without success.

Reports indicating the occurrence of *Dipetalogaster maximus* in the United States appear to be in error. In 1906 F.H. Snow left Kansas on an entomological expedition to Arizona. During this collecting trip some kissing bug specimens were collected and incorrectly identified as being of the species *maximus*. The only Triatominae in the Snow Museum at Lawrence, Kansas collected by F.H. Snow are seven specimens of *Triatoma rubida uhleri* (3 males and 3 females from the Baboquivari Mts in Pima County and 1 female from Douglas, Cochise Co., Arizona). Since Snow's (1907:160) report on this expedition a number of authors have reported *D. maximus* from "California, Arizona or

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