

## An illustrated key to the eggs of thirty species of brazilian anophelines, with several new descriptions\*

Causey, O. R.

Deane, L. M.

Deane, M. P.

Laboratory of the Serviço de Malaria do Nordeste at Fortaleza, Brazil and  
International Health Division of The Rockefeller Foundation

An accurate knowledge of all stages of the life cycle of a given species of mosquito from egg to adult is a prerequisite for the conduct of a comprehensive anopheline survey in areas where the anopheline fauna is not well known. A method to facilitate the collection and shipping of specimens was devised<sup>1</sup> and used in the course of malaria investigations in Brazil. For the present study ovipositions from more than 28,000 isolated female anophelines were collected and studied by this method and many batches of eggs hatched and reared to adult forms. These represent 30 species obtained from the Amazon Valley and the northeastern and eastern coastal regions.

The isolated female anophelines which oviposited are classified in table 1 according to species and the locality in which they were collected. Three other species, *Anopheles (Stethomyia) thomasi*, *Anopheles (Lophopodomyia) squamifemur*, and *Anopheles (Anopheles) punctimacula*, were also found in the areas investigated, but eggs were not obtained. Thirty ovipositions from isolated females are recorded for *Anopheles (Myzomyia) gambiae*. In addition more than 60,000 eggs, corresponding to about 400 ovipositions of wild and colony bred

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*A. gambiae* mosquitoes grouped in cages were counted and studied<sup>2,3</sup>. Although this species is no longer present in Brazil<sup>4</sup>, the egg is included in this tabulation and in the key for reference should this malaria vector again invade South America.

During the course of this study three new species, *Anopheles (Nyssorhynchus) sawyeri*<sup>5</sup>, *Anopheles (Nyssorhynchus) galvãoi*<sup>6</sup>, and *Chagasia rozeboomi*<sup>9</sup> have been reared from eggs and described. The egg, larva, and pupa of *Anopheles (Arthuromyia) gilesi*<sup>7</sup> have been reported and the eggs of *A. albitarsis* and *A. darlingi* redescribed from Brazil<sup>8</sup>. The heretofore undescribed eggs of several other old species have also been collected and are now being recorded for the first time. These are *Anopheles kompi*, *A. nimbus*, *A. peryassui*, *A. shannoni*, *A. matto grossensis*, *A. fluminensis*, *A. minor*, and *A. parvus*.

The eggs of all species were photographed and camera lucida drawings made of representative specimens and of the principal variants. Photographs of these drawings are reproduced in Plates 1 and 2

#### DESCRIPTION OF EGGS HERETOFORE UNKNOWN

*Anopheles (Stethomyia) kompi* Edwards 1930. Eggs resemble those of *Anopheles pseudopunctipennis*. Anterior end stout, posterior end tapering; exochorion with polygonal pattern on all exposed parts except small area between floats; floats short and continuous anteriorly, fused at posterior end; circular collar formed by broad frill situated dorsally at posterior end, in contact with fused posterior tips of floats (Plate 1)

Table 1 – Ovipositions by isolated *anopheline* mosquitoes collected in Brazil

Species	Territory of Acre	Amazonas	Pará	Maranhão	Piauí	Ceará	Rio Grande do Norte	Parabá	Pernambuco	Alagoas	Rio de Janeiro	Totals
<i>C. rozeboomi</i>						25						25
<i>A. kompi</i>						20		1				21
<i>A. nimbus</i>			1	5								6
<i>A. eiseni</i>						35						35
<i>A. peryassui</i>		9	147	3			19	1	4	6		189
<i>A. mattogrossensis</i>	3	505	1									509
<i>A. shannoni</i>			3									3
<i>A. fluminensis</i>						2					3	5
<i>A. intermedius</i>			107					1	17	147	331	603
<i>A. minor</i>								3	61	34		98
<i>A. maculipes</i>											1,239	1,239
<i>A. mediopunctatus</i>		9	11	5		73				6		104
<i>A. parvus</i>						298						298
<i>A. argyritarsis</i>				1	30	1,573	35	64	167	5	27	1,902
<i>A. sawyeri</i>						315						315

(continua)

Table 1 – Ovipositions by isolated *anopheline* mosquitoes collected in Brazil

Species	(conclusão)											
	Territory of Acre	Amazonas	Para	Maranhão	Piauí	Ceará	Rio Grande do Norte	Parabá	Pernambuco	Alagoas	Rio de Janeiro	Totals
<i>A. albitalaris</i>	81	44	746	64	686	1,573	705	538	920	470	1,089	6,916
<i>A. pessoai</i>		102	433	4		18	7	75	81	21		741
<i>A. darlingi</i>		45	1,621	40	269	1				171	419	2,566
<i>A. aquasalis</i>			433	148		405	6	3	271	6	1,012	2,284
<i>A. goeldii</i>	88	237	1,224	183	340							2,072
<i>A. noroestensis</i>				13	11	158	5	7	333	305	9	481
<i>A. oswaldoi</i>	40	191	159	11	1			1	4		294	701
<i>A. konderi</i>	7	7	1									15
<i>A. galvãoi</i>	40	1										41
<i>A. bemarochi</i>	166											166
<i>A. rangeli</i>	407											407
<i>A. strodei</i>				22	169	1,211	80	349	517	410	30	1,402
<i>A. triannulatus</i>	113	967	397	296	1,655	76						4,890
<i>A. gilesti</i>						13						13
<i>A. gambiae</i>						30						30
Totals	945	2,117	5,284	795	3,161	5,826	857	1,043	2,375	1,581	4,453	28,437

*Anopheles (Stethomyia) nimbus* Theobald 1902. Similar to *Anopheles kompi* but with collar placed dorsoapically and formed by broader frill (Plate 1)

*Anopheles (Anopheles) peryassui* Dyar and Knab 1908. Similar to *Anopheles shannoni*; floats long, narrow, laterally placed, curved in wide arc approximating each other at anterior and posterior ends of eggs, formed by about 22 ridges with filamentous extensions longer toward extremities of egg, the 2 or 3 ridges at center usually devoid of these extensions; exochorion showing hexagonal pattern over exposed surface (Plate 1). Ovipositions from mosquitoes collected in Amapá, State of Pará, and Bôa Vista, State of Amazonas, differ from common *peryassui* type by showing shorter floats separated at tips by anterior and posterior collars of narrow frills enclosing rounded or oval areas without pattern, usually small (Plate 2, a) but sometimes extending nearly one-quarter the length of the egg (Plate 2, b)

*Anopheles (Anopheles) mattogrossensis* Lutz and Neiva 1911. Strongly concave dorsally with very pointed tips; exposed surface showing reticulated polygonal pattern except on narrow dorsal longitudinal band enclosed by narrow and sinuous frill, slightly broadened at extremities; floats broad and long with about 40 ridges; in many eggs frill not continuous but interrupted, usually near center of egg (Plate 2, c), and in some specimens showing one or more isolated small areas along longitudinal line (Plate 2, d)

*Anopheles (Anopheles) shannoni* Davis 1931. Similar to *A. peryassui* but broader, with broader floats curved near each extremity at right angles and approximating each other dorsally, exposing large areas at anterior and posterior ends of egg; floats composed of 34 to 38 ridges; filaments as in *A. peryassui* much longer near each end of egg; exochorion showing reticulated polygonal pattern on exposed surface (Plate 2)

*Anopheles (Anopheles) fluminensis* Root 1926. Slightly concave dorsally; floats long and nearly parallel at dorsal margins; wide, regular frill surrounding wide, elliptical black area, truncate at ends; surface with reticulated hexagonal pattern except on area enclosed by frill (Plate 1)

*Anopheles (Anopheles) minor* Lima 1929. Strongly concave dorsally; floats with about 30 ridges; frill not sinuous, enclosing narrow black area expanded at extremities and extending length of egg; surface exhibiting reticulated polygonal exochorion except for area enclosed by frill (Plate 1). One oviposition was observed in which frill was confined to extremities surrounding small elliptical areas at each end of dorsal surface.

*Anopheles (Myzorrhynchella) parvus* Chagas 1907. Long and narrow, lateral view with appearance of baby's bottle complete with nipple; floats narrow, dorsally placed, fused at ends; frill forming wide collar completely surrounding anterior end of egg, which terminates in spine-like projection; exochorion without pattern (Plate 1)

*Chagasia rozeboomi* sp. n. Eggs strongly convex ventrally and concave dorsally; about 6 parallel floats tightly approximated over surface of egg except for broad longitudinal band enclosed by frill, and narrow longitudinal bands of reticulated exochorion at sides of frill and at ventral surface; about 12 transverse attachments between floats and frill on dorsal surface; each extremity of egg surmounted by thick, whitish, spongy cap-like structure (Plate 1). In some specimens one or more floats are interrupted instead of extending from tip to tip of egg (Plate 2)

## KEY FOR IDENTIFICATION OF EGGS

The technique employed in this study, by providing infallible association of the egg, larva, and adult of each species, has made it possible to evaluate the use of egg morphology for taxonomic purposes. The egg characters constitute an excellent means for the separation of certain closely related female anophelines and can be used for the identification of most of the anophelines so far encountered in Brazil. An illustrated key for this purpose has accordingly been devised. Identifying characteristics have been derived from the floats, frills, and appearance of the egg. These are described in 28 couplets by analyzing the number, position, length, width, and structure of the floats and frills; the shape and size of the egg; and the pattern of the exochorion.

In couplet 24 the types of *Anopheles aquasalis* and *Anopheles triannulatus* showing two collars are not differentiated. However, when many ovipositions of both species are studied it is readily observed that the *triannulatus* egg is slightly narrower and that the floats appear to be more closely applied to the surface of the egg. These same observations apply to the types of these species with one collar keyed out in couplet 22. Occasionally it is necessary to examine the ovipositing females which in these species are easily differentiated.

The eggs of the remaining species keyed out in the first part of couplet 22, *Anopheles noroestensis*, *Anopheles oswaldoi*, and *Anopheles konderi*, are relatively wider but are more difficult to distinguish from each other. However, here too, simultaneous examination of the eggs and ovipositing adults will give correct diagnoses in the hands of experienced observers, and differences in appearance, not susceptible to the rigid definitions of a key, may be readily detected.

KEY FOR EGGS OF ANOPHELINE MOSQUITOES  
COLLECTED IN BRAZIL

1. Floats numerous ..... (Genus *Chagasia*. *C. rozeboomi*)  
    Floats paired, dorso-lateral or absent ..... (Genus *Anopheles*) 2
2. Floats present, paired, dorso-lateral ..... 3  
    Floats absent ..... 17
3. Frills absent or not continuous with floats ..... 4  
    Frills continuous with floats ..... 18
4. Exochorion without pattern; spine projecting from area enclosed  
    by frill ..... *A. parvus*  
    Exochorion with pattern ..... 5
5. Pattern hexagonal ..... 6  
    Pattern of white dots ..... 25
6. Float ridges with filamentous tips, frills absent ..... 7  
    Float ridges without filamentous tips, frills present ..... 8
7. Floats narrow, almost as long as egg, with about 22 ridges ..*A. peryassui*  
    Floats wide, much shorter than egg, with about 34 to 38 ridges .....  
    ..... *A. shannoni*
8. Floats fused anteriorly; distinct collar posteriorly ..... (*Stethomyia*) 9  
    Floats not fused anteriorly ..... 10
9. Posterior collar situated dorsally; frill narrower than *A. nimbus* *A. kompi*  
    Posterior collar situated dorso-apically, frill broader than *A. kompi* .....  
    ..... *A. nimbus*
10. Floats narrow ..... 11  
    Floats wide ..... 12
11. Striation on frill oblique ..... *A. intermedius*  
    Striation on frill at right angles ..... *A. maculipes*
12. Frill wide, enclosing wide longitudinal black band ..... *A. fluminensis*  
    Frill narrow ..... 13
13. Floats with about 30 ridges or less ..... 14  
    Floats with about 40 ridges ..... 16
14. Frill sinuous ..... *A. eiseni*  
    Frill not sinuous ..... 15



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15. Eggs more pointed, area enclosed by frill narrow ..... *A. minor*  
Eggs less pointed, area enclosed by frill broad ..... *A. gambiae*
16. Eggs strongly concave dorsally, with sharply pointed tips; frill very sinuous  
enclosing narrow band which usually extends from tip of egg .  
..... *A. mattogrossensis*  
Eggs with slight or no concavity dorsally, tips not finely pointed; frills  
usually enclosing small terminal areas ..... *mediopunctatus*
17. Frill regular, broad at ends, laterally placed, enclosing entirely exposed  
dorsal surface with hexagonal pattern ..... *A. sawyeri*  
Frill sinuous, only slightly broadened at ends, dorsally placed enclosing  
narrow band without hexagonal ..... pattern in part *A. pessoai* (1)
18. Exochorion without distinct pattern ..... 19  
Exochorion with definite pattern of white dots ..... 21
19. Float ridges wavy, refractile ..... *A. argyritarsis*  
Float ridges straight, less refractile to light ..... 20
20. Frill sinuous; floats dorsally placed, usually smaller and with fewer ridges  
in part *A. pessoai* (2) Frill not sinuous, floats laterally placed, usually longer  
and with more ridges ..... *A. albitarsis*
21. Frill at anterior end only ..... 22  
Frills at anterior and posterior ends ..... 23
22. Floats extending to a point midway on anterior collar .... *A. noroestensis*  
*A. oswaldoi*  
*A. konderi*  
in part *A. aquasalis* (1)  
in part *A. triannulatus* (1)  
Floats extending to a point of lower quarter of anterior collar . *A. galvãoi*
23. Frills wide, placed at extreme tip of eggs; floats usually laterally placed. ...  
..... *A. goeldii*  
Frills narrow, dorsally placed ..... 24
24. Areas enclosed by frill ovoid, float ridges straight .....  
..... in part *A. aquasalis* (2)  
in part *A. triannulatus* (2)  
Areas enclosed by frills with slight enlargement near tips of floats; float  
ridges wavy ..... in part *A. strodei* (1)
25. Floats not fused at both ends; frills enclosing small space at each end 26  
Floats fused at both ends; frills present at anterior end ..... 27

26. Floats laterally placed extending almost complete length of egg; ridges indistinct at median portion ..... *A. gilesi*  
 Floats dorsally placed, not extending total length of egg; ridges distinct in part *A. strodei* (2)
27. Frills forming wide anterior collar on dorsoapical portion ..... 28  
 Frills forming narrow anterior collar on dorsal surface ..... *A. benarrochi*
28. Floats short, leaving large portion of posterior dorsal surface exposed ..... *A. darlingi*  
 Floats extending to posterior end ..... *A. rangeli*

#### DESCRIPTION OF EGG VARIATIONS

Besides the unusual forms already mentioned for species of which the eggs were previously unknown, the following variations may be mentioned for other species (Plate 2).

*Anopheles (Anopheles) intermedius* Chagas 1908. Frill instead of extending from tip to tip of egg may be interrupted, covering only portion of longitudinal line, with or without additional collar-like formation between tip of interrupted frill and end of egg (Plate 2, f and g).

*Anopheles (Anopheles) mediopunctatus* Theobald 1903. Specimens from northeastern Brazil are as depicted in plate I. In most specimens from the Amazon region the areas enclosed by frills are larger and more elongated (Plate 2, h). Occasionally an extra frill surrounds isolated small area on median line (Plate 2, i). The frill is rarely continuous from tip to tip of egg, enclosing narrow black band (Plate 2, j)

*Anopheles (Nyssorhynchus) albitarsis* Lynch-Arribalzaga 1878. Average length of floats in specimens from the Amazon region, Maranhão, Piauí, and Ceará is greater than in those from Rio Grande do Norte, Paraíba, and Rio de Janeiro.

*Anopheles (Nyssorhynchus) pessoai* Galvão and Lane 1936. Eggs with and without floats are observed in the Amazon region, but all eggs of given oviposition are of one type, i.e., all with or all

without floats. Ovipositions from northeastern Brazil are usually of type without floats, but eggs without and with rudimentary floats are sometimes found in same oviposition. (Plate 2, k). Occasionally frill is interrupted, leaving two long openings at either end (Plate 2, l); many eggs found with reticulated, irregular polygonal pattern faintly visible on exochorion not enclosed by frill.

*Anopheles (Nyssorhynchus) darlingi* Root 1926. The eggs are usually of typical morphology, with occasional variations as follows:

1. Normal eggs with unexpanded collar (Plate 2, m);
2. Collar continuous with floats (Plate 2, n);
3. Same with posterior collar also present and continuous with floats (Plate 2, o);
4. Anterior collar not continuous with floats, small posterior collar present and continuous with floats (Plate 2, p);
5. Anterior collar normal, posterior collar present and isolated from floats (Plate 2, q).

*Anopheles (Nyssorhynchus) aquasalis* Curry 1932. Eggs range in morphology from typical *oswaldoi* type with anterior collar and closely approximated floats, to typical *aquasalis* type with two collars and large exposed area between floats. Closed type of egg is most frequent in southern and northeastern Brazil. Open type with two collars is common in the Amazon region. All variations occasionally occur in same oviposition.

*Anopheles (Nyssorhynchus) goeldii* Rozeboom and Gabaldon 1941. Eggs are usually typical in morphology. Occasionally floats are dorsally placed and closely approximated at median line (Plate 2, r).

*Anopheles (Nyssorhynchus) strodei* Root 1926. Eggs show much variation. The following types were observed, all with rather long floats of 20 to 24 ridges:

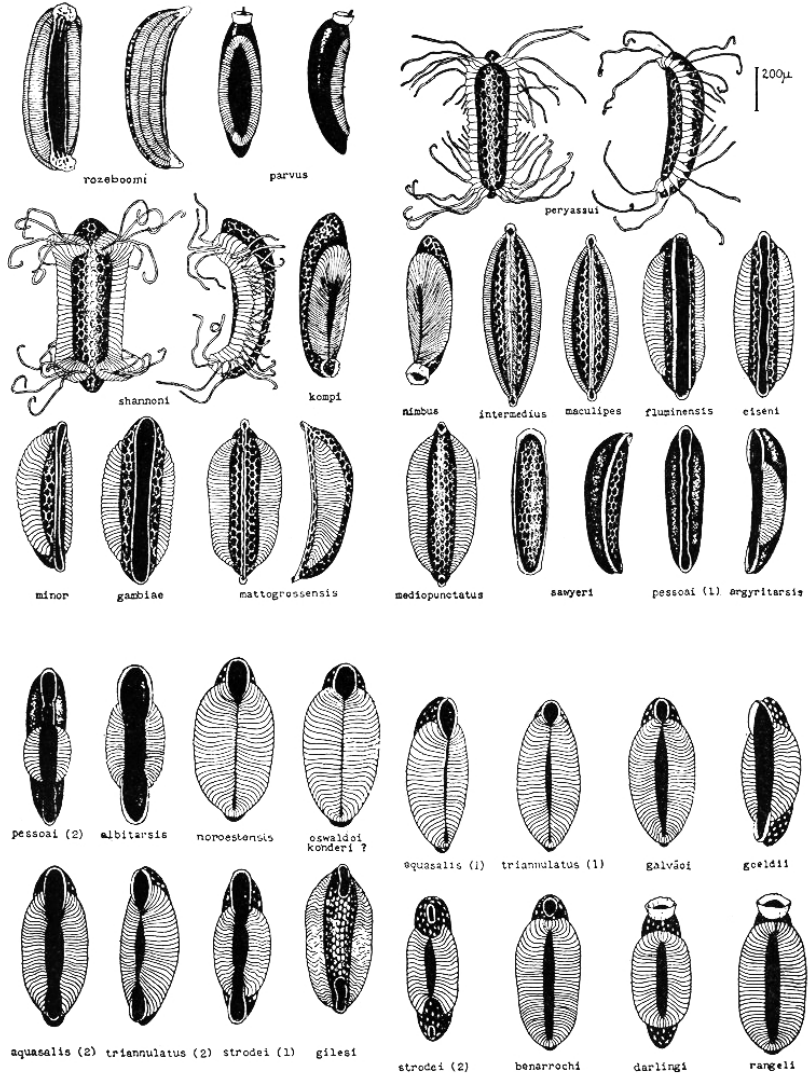
1. Frills present only at one end of egg, isolated from floats and enclosing small, ovoid area (Plate 2, s);
2. Frill present at both ends, isolated from floats (Plate 2, *strodei* 2);
3. Anterior frill continuous with floats enclosing large area, posterior frill small, isolated from floats (Plate 2, t);
4. Frill continuous with floats at both ends, floats closely approximated (Plate 2, u);
5. Frill continuous with floats at both ends; floats far apart (Plate 2, *strodei* 1);

*Anopheles (Nyssorhynchus) triannulatus* Neiva and Pinto 1922. Four types of eggs all clearly distinguished are oviposited by *triannulatus*:

1. Narrow frill surrounding small area at anterior portion of dorsal surface (Plate 1, *triannulatus* 1);
2. Anterior and posterior frill present, posterior frill smaller; floats closely approximated (Plate 2, v);
3. Anterior and posterior frills enclosing large areas, and a spindle-like area between floats (Plate 1, *triannulatus* 2);

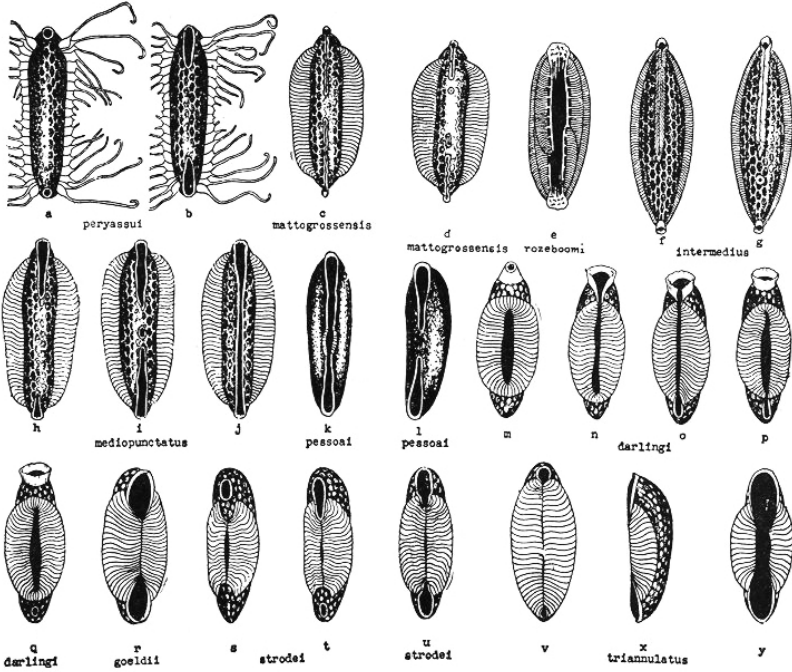
Plate 1

Typical eggs of 30 species of anopheline mosquitoes from Brazil



## Plate 2

Atypical eggs of 10 species of anopheline mosquitoes from Brazil



The first two types occur in northeastern Brazil, the eggs with one frill being the more prevalent in most regions. In the southern and western parts of Ceará and in the Parnahiba valley and in Piauí the second type is found frequently. In the Amazon region the type with single frill is also most common and is distributed throughout the valley, from Pará, where it appears to be the only type, to the most remote regions so far examined. Up the river from Monte Alegre, type 2 becomes frequent. Type 3 is abundant in the valley above Manaus. Type 4 has been found only in rather remote areas such as Guayara-Merín (Bolivia), Rio Branco (Acre), Labrea and Manicoré (Amazonas), and even in these areas only a few ovipositions with eggs of this morphology were obtained.

#### SUMMARY

Ovipositions from more than 28,000 isolated females, representing 30 species of anopheline mosquitoes collected in Brazil, were studied, and the eggs of nine species described for the first time. A key to the eggs of these 30 species based primarily on the floats, frills, and pattern of exochorion is presented and illustrated by camera lucida drawings of typical specimens of each species. Some commonly encountered varieties of several species are also described and illustrated.

#### REFERENCES

1. Causey, O. R. A method for the collection, transportation, and study of anopheline eggs and adults. *Amer. Jour. Trop. Med.*, 1943, 23: 133-137.
2. Causey, O. R., Deane, L. M. and Deane, M. P. Ecology of *Anopheles gambiae* in Brazil. *Amer. Jour. Trop. Med.*, 1943, 23: 73-94.
3. Deane, M. P. and Causey, O. R. Viability of *Anopheles gambiae* eggs and morphology of unusual type found in Brazil. *Amer. Jour. Trop. Med.*, 1943, 23: 95-103.

4. Soper, F. L., and Wilson, D. B. *Anopheles gambiae* in Brazil, 1930 to 1940. The Rockefeller Foundation, New York, 1943. 262 p.
5. Causey, O. R., Deane, L. M., Deane, M. P., and Sampaio, M. M. *Anopheles (Nyssorhynchus) sawyeri*, a new anopheline mosquito from Ceará, Brazil. *Ann. Ent. Soc. Amer.*, 1943, 36:11-20.
6. Causey, O. R., Deane, L. M. and Deane, M. P. Description of a new anopheline mosquito from the upper Amazon Valley, *Anopheles (Nyssorhynchus) galvãoi* n. sp. São Paulo. In press.
7. Deane, L. M., Deane, M. P., and Causey, O. R. Descrição do ovo, larva e pupa do *Anopheles (Arthuromyia) gilesi* (Neiva 1908). Papeis Avulsos, *Archivos de Zoologia*. In press.
8. Causey, O. R., Deane, L. M., Deane, M. P., and Sampaio, Machado. Note clarifying the status of *Anopheles albitarsis* and *Anopheles darlingi* (Diptera: Culicidae). *Proc. Ent. Soc. Wash.*, 1942, 44:122-126.
9. Causey, O. R., Deane, L. M., and Deane, M. P. *Description of C. rozeboomi* sp. n. Ms. in preparation.

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