Saurian Malarial Parasites in Eastern Panama

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SYNOPSIS. *Plasmodium gonatodi* sp. nov. is described from *Gonatodes albogularis fuscus* of eastern Panama. It is characterized by elongate gametocytes and polymorphic schizonts containing 12-46 nuclei when apparently mature. Both proerythrocytes and erythrocytes are commonly parasitized, host cells are hypertrophied and distorted, and their nuclei are displaced. Prematuration sexual stages may be irregularly shaped and larger than mature gametocytes.

Plasmodium diploglossi Aragão and Neiva, 1909 is reported from *Mabuya mabouya* in eastern Panama, and *Plasmodium*

morulum sp. nov. is described from this host. *P. morulum* usually parasitizes immature erythrocytes, and is characterized by lenticular or oval to round gametocytes, and schizonts with 14-40 nuclei usually arranged in a globular mass. Host cells are slightly hypertrophied and distorted, and their nuclei are usually displaced. Inoculation of infected blood into clean hosts produces numerous schizonts in white cells as well as in the erythrocyte series.

Pigment in both *P. gonatodi* and *P. morulum*, if present, consists of a few minute dark dots which do not meet the polarized light test for hemozoin.

DURING field work conducted by Gorgas Memorial Laboratory in extreme eastern Panama in September and December 1968, and March and June 1969, a total of 164 lizards of 11 species was collected and examined for blood parasites. Five species were found positive for *Plasmodium* spp.; the parasites of 2 hosts, *Gonatodes albogularis fuscus* (Sphaerodactylidae) and *Mabuya mabouya* (Scincidae) are described in this report.

MATERIALS AND METHODS

All lizards were collected by hand and most were brought alive by air to the laboratory in Panama City. A few slides were made in the field from specimens which died there, or immediately upon arrival from those which died en route. Slides were fixed in absolute methanol and stained for 1-1.5 hr with a 1:10 dilution of Giemsa at pH 6.8. Slides were examined at 600 × and 1000 × oil immersion, and photomicrographs were taken at 1000 ×. Strain isolations were made by inoculation of blood from infected lizards into lizards collected from localities in central Panama where these particular host species have not yet been found infected. Descriptions below are based upon study of both natural infections and lizards infected by blood inoculation. Measurements of parasites are in micra. Schizonts were considered to be "apparently mature" when segmentation seemed to be imminent or was observed.

RESULTS

The malarial parasite of Gonatodes albogularis fuscus.

A total of 46 *Gonatodes albogularis fuscus* from Sasardi, San Blas Territory, eastern Panama was examined; 13 (28%) were found infected with a *Plasmodium* species. Examination of 92 additional *Gonatodes* collected from Panama, Colon, and Coclé provinces, the Canal Zone, and

Panama City were negative for *Plasmodium*. Study of this parasite from Sasardi *Gonatodes* revealed that it cannot be assigned to any known species of saurian *Plasmodium*, and I therefore designate it:

Plasmodium gonatodi sp. nov.

DIAGNOSIS: A species of *Plasmodium* which produces polymorphic schizonts containing 12-46 nuclei and elongate gametocytes. Immature gametocytes are pointed at both ends and develop into prematuration stages which are often larger than mature gametocytes and irregularly shaped. Host cells are hypertrophied and distorted, and their nuclei are usually displaced. Trophozoites usually parasitize erythrocytes and proerythrocytes, and occasionally normoblasts. Minute dark granules occasionally seen in the cytoplasm of some stages in ordinary light do not give the test for hemozoin when examined in polarized light.

DESCRIPTION: *Trophozoites.* The youngest stages seen were rounded, about 1 in diameter, with no cytoplasm visible. A vacuole nearly encircled by a thin band of nuclear material usually formed before cytoplasm became visible; the trophozoite was about 3 by 1.5, and roughly triangular or wedge-shaped (Fig. 3). The vacuole often disappeared at this stage. The largest uninucleate stage seen was elongate, 6 by 2, with a central nucleus, one extremity bluntly irregular and the other acuminate. The smallest trophozoites occupied any portion of the host cell, but as they grew they usually came to lie lateral to the host cell nucleus.

Schizonts. Binucleate schizonts ranged from 5 by 2 to 7 by 2; one end was often rather blunt and the other drawn out into a thin cytoplasmic projection. Schizonts

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at the 8-nucleate stage (Fig. 4) might be 11 by 4; as nuclear division continued, the schizont often became elongate. The cytoplasm stained pale to medium blue, and the nuclei deep red. Mature schizonts were highly polymorphic (Figs. 7-15), round to elongate, often curving around the host cell nucleus (Figs. 9, 10, 12, 13). Some of the elongate forms had a narrowing of the cytoplasm, (Figs. 10, 13), suggesting a tendency for blocks of nuclei to pinch off (Fig. 11), giving rise to apparent multiply-infected host cells which in reality may have originated from invasion by a single parasite. Schizonts were 8-19 by 4-9, with a mean of 11.8 by 6.1. There were 12-46 nuclei in apparently mature schizonts, with a mean of 28.0. Free merozoites averaged about 2.5 by 1, and contained slightly more cytoplasm than nuclear material (Fig. 2). They varied in form from drop-shaped to slightly elongate, blunt at one end and sharply pointed at the other.

Gametocytes. The smallest parasites clearly distinguishable as gametocytes were about 8 by 3, elongate, with both ends pointed (Fig. 16). Mature gametocytes (Figs. 18-25) were usually elongate and banana-shaped, but approximately 5% in some infections were oval or rounded (Fig. 20). There was no sexual dimorphism in size or shape. Macrogametocytes stained medium to deep blue, with their nucleus visible only as a pinkish, irregularly shaped area in the middle of the gametocyte. A pink nucleolus, 1 in diameter, might be visible at the edge of the nuclear area. Microgametocytes were unstained or pink. Their nuclei might be indicated by broad areas of scattered pink spots sometimes observed at midbody. The elongate gametocytes were 14-21 by 4-7 with a mean of 16.9 by 5.1. Rounded gametocytes from one infection were 7-14 by 5-10, with a mean of 10.3 by 7.6. Staining characteristics were similar to those of the elongate forms. Elongate gametocytes were usually lateral to the host cell nucleus, but one or both ends often curled slightly around the nucleus. Occasional host cells in which the parasite seemed to encircle the nucleus completely (Fig. 23) probably contained more than one parasite. Rounded gametocytes occurred in lateral (32%), polar (40%), or lateropolar (28%) positions within host cells.

The younger asexual stages showed no evidence of pigment. Minute black dots were present in 16-40% of the segmenters, and in most of the gametocytes, but they were not refractile when examined under polarized light. If the polarized light test for hemozoin (5) is valid, this suggests that true pigment is lacking in this species. The nature of these granules must await more exacting study.

What are interpreted here to be pre-maturation stages of gametocytes are characteristic of this species. In all infections studied, many bizzare forms were found (Figs. 26-30) which were clearly gametocytic in nature but often larger than those stages considered to be mature gametocytes. In some, the parasite surface adjacent to the host cell nucleus was crudely scalloped or rugose while in others one end of the parasite protruded like a tail (Fig. 28). Most of these forms had chromatin distributed thruout the body of the parasite, while a few were found in which the chromatin material was clumped in the middle of the parasite (Fig. 24), causing it to resemble certain haemogregarines. Typical haemogregarines were not encountered in the Sasardi population of *Gonatodes,* but were found in a Panama City population. The identity of these bizarre forms cannot be determined from the present material.

Exoerythrocytic stages. A single exoerythrocytic schizont was seen in a lymphocyte (Fig. 1). It contained 22 nuclei.

Types of host cells parasitized. Samples of 50 uninucleate and binucleate parasites in 2 infections occurred in equal numbers in erythrocytes and proerythrocytes, while in a 3rd infection 76% were in erythrocytes and 24% in proerythrocytes. Parasites were found in normoblasts (17%), proerythrocytes (43%), and erythrocytes (40%) in a 4th lizard.

In 3 infections, schizonts were found only in erythrocytes (100, 76 and 24%), and proerythrocytes. All mature gametocytes were found in erythrocytes, altho some immature gametocytes parasitized proerythrocytes.

Effects upon host cells. The effects of both schizonts and gametocytes upon host cells were similar: Host cell width was increased and its shape distorted. Nuclei of mature erythrocytes were neither distorted nor enlarged by the presence of parasites, but were displaced (84-100%) by mature schizonts. Gametocytes displaced host cell nuclei less often (34-75%) than did mature schizonts. There was no apparent effect upon host cells by trophozoites or young schizonts.

TYPE HOST: *Gonatodes albogularis fuscus* (Hallowell) (Sauria, Sphaerodactylidae).

TYPE LOCALITY: Sasardi, San Blas Territory, Republic of Panama.

GEOGRAPHIC RANGE: Known only from the type locality.

Figs. 1-15. Asexual stages of *P. gonatodi* sp. nov.
Fig. 1. EE-schizont in lymphocyte.
Fig. 2. Free merozoites.
Fig. 3. Triple infection of trophozoites in erythrocyte.
Fig. 4. Young schizonts in erythrocyte.
Fig. 5. Schizont in probable normoblast.
Fig. 6. Schizont in proerythrocyte.
Figs. 7-10. Schizonts in erythrocytes.
Fig. 11. Broken schizont and trophozoite in proerythrocyte.
Figs. 12-14. Schizonts in proerythrocytes.
Fig. 15. Schizont near rupture in proerythrocyte.

Figs. 16-25. Gametocytes of *P. gonatodi.*
Fig. 16. Immature gametocytes in proerythrocytes.
Fig. 17. Immature gametocyte in erythrocyte.
Figs. 18-20. Mature macrogametocytes in erythrocytes.
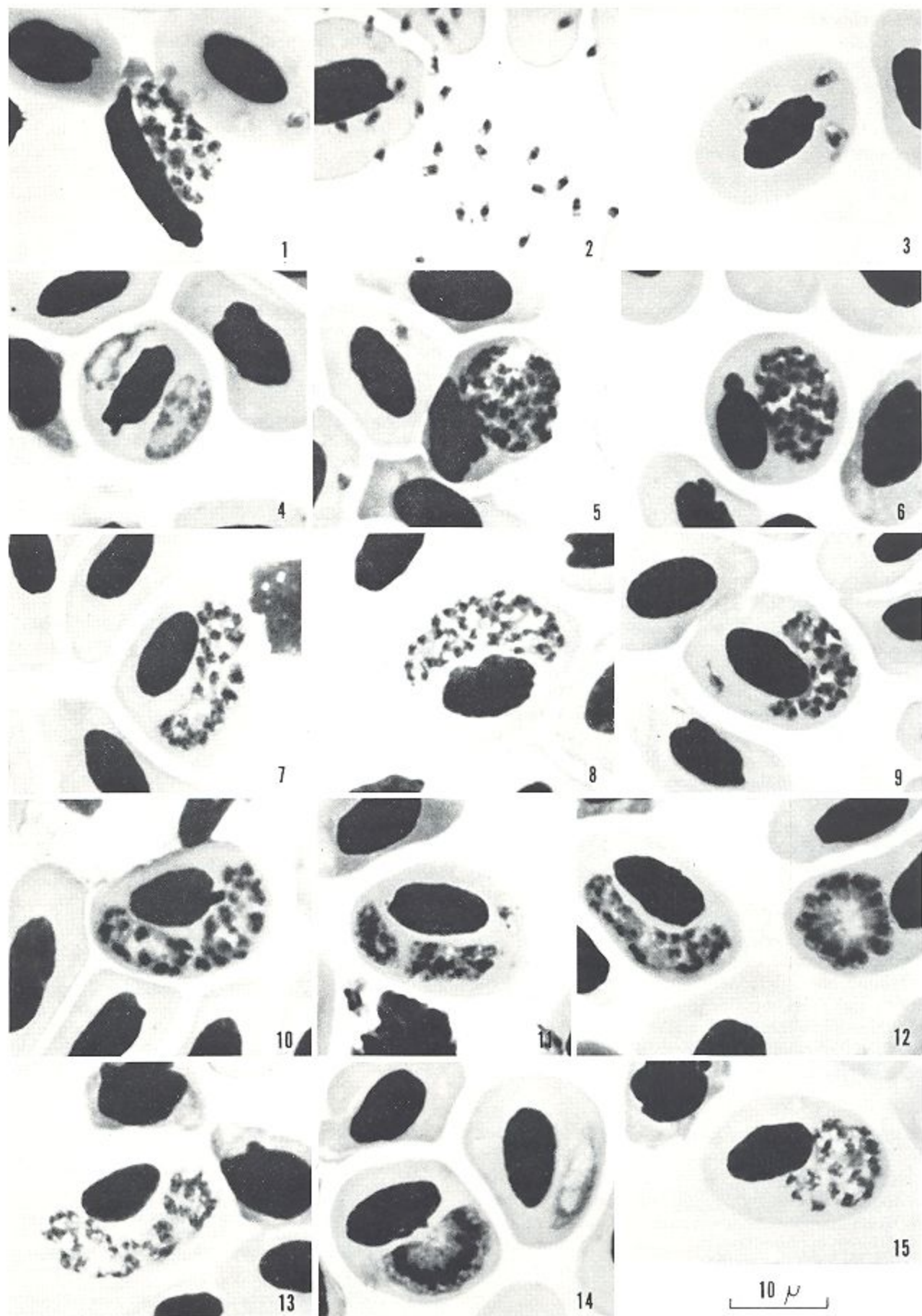Fig. 21. Mature microgametocyte in erythrocyte.
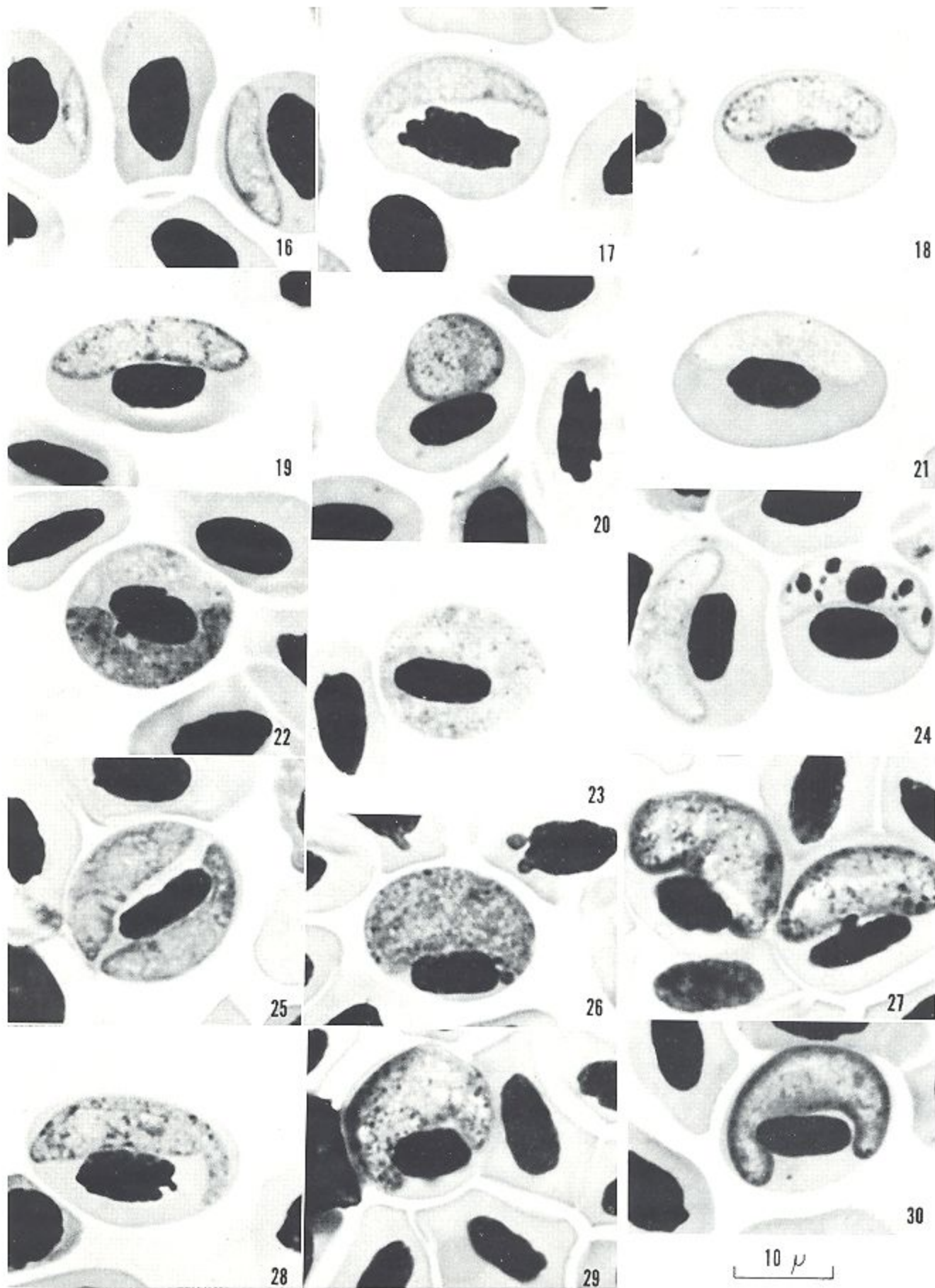Fig. 22. Micro- and macrogametocytes in erythrocyte.
Fig. 23. Microgametocytes in erythrocyte.
Fig. 24. Microgametocyte and abnormal microgametocyte in erythrocytes.
Fig. 25. Macrogametocyte in erythrocyte.
Figs. 26-30. Prematuration stages of *P. gonatodi* macrogametocytes in erythrocytes.

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LOCATION OF TYPES: The series of type slides is retained at present in my collection. Paratypes are deposited in the Dept. of Zoology, Univ. of California, Los Angeles, and with Prof. P. C. C. Garnham, Imperial College Field Station, Silwood Park, England.

The malarial parasites of Mabuya mabouya

A total of 11 *Mabuya mabouya* was collected at Sasardi, 5 of which were positive for malarial parasites. Two distinctive *Plasmodium* species were encountered. Examination of 47 other *Mabuya* from Colon and Panama provinces, the Canal Zone, and Panama City revealed no infected lizards.

One of the *Plasmodium* species found in 4 Sasardi *Mabuya* is apparently *P. diploglossi*, reported from Brazilian skinks identified as *Mabuya mabouya* by Lainson and Shaw (9). Certain differences exist which may eventually justify taxonomic distinction, but for the present I consider this species to be *Plasmodium diploglossi* and describe it in detail below.

Plasmodium diploglossi from Panamanian Mabuya mabouya

Trophozoites. The smallest stages seen were 1 in diameter, roughly triangular, with no cytoplasm visible. As the trophozoite grew to about 2 by 1, the pale blue cytoplasm approximated the nucleus in size, and a light spot appeared in the cytoplasm which developed into a vacuole (Fig. 31). The cytoplasm formed a thin band on one side of the vacuole, while the chromatin material was stretched along the other side. No pigment was present at this stage. Uninucleate parasites 3 by 1.5-2 had a small pigment dot. The largest uninucleate parasite seen was 6 by 3. The smallest parasites were anywhere in the host cell cytoplasm, but the larger trophozoites were almost always nucleophilic, lying in contact or nearly so with the host cell nucleus (Fig. 31).

Schizonts. The smallest binucleate schizont seen was 4 by 4, and pigmented, while the largest containing 2 nuclei were 7-8 by 3. The smaller stages were variable in shape, rounded or elongate; as they grew they usually became roughly oval, flattened on the host cell nucleus side, with occasional short, blunt cytoplasmic projections. Larger binucleate schizonts contained a prominent golden yellow pigment mass. Schizonts might contain 4 nuclei at 7 by 3; with further nuclear division their shape might become irregular. As division occurred schizonts usually elongated and curved around the host cell nucleus (Fig. 32). Mature schizonts were usually elongate, with golden

yellow pigment in a large clump at one end of the parasite. They were 6-20 by 3-8 in width, with a mean of 13.4 by 4.3. There were 11-40 nuclei in apparently mature schizonts, with a mean of 25.4. Pigment was always present, and prominent. From 56 to 90% of the schizonts curved around the nucleus to some degree (Figs. 34, 36, 39, 40), but only one of hundreds was observed to encircle the nucleus completely (Fig. 35), and in this case it cannot be certain that multiple infection was not involved. Multiple infections of up to 8 parasites were common in one massive infection studied. Free merozoites were about 1.5 by 1, and roughly triangular, consisting mostly of chromatin.

Gametocytes. Gametocytes of both sexes were oval to elongate bean-shaped (Figs. 42-46), and only 4-8% curved noticeably around the host cell nucleus (Fig. 42-43). A single infected cell was seen in which the cytoplasm seemed to be completely filled by parasite, and again the possibility of double infection cannot be discounted. Gametocytes ranged from 7-17 by 4-8 with a mean of 11.2 by 5.4. Macrogametocytes had a granular cytoplasm which stained deep blue. A faint, irregular pink area in the center denoted the nucleus, which often contained a round, red nucleolus. Microgametocytes were pale, with a faint, diffuse pink area in the center which was probably the nucleus. The pigment in both sexes was in the form of about 20-30 nearly black granules scattered over the parasite.

Exoerythrocytic stages. Two EE-schizonts have been seen: one, in a lymphocyte contained 12 nuclei, and another, in a thrombocyte, had 18 nuclei.

Effects upon host cells. Schizonts. Small asexual parasites had no apparent effect upon host cells, but as nuclear division proceeded, host cells became broader and sometimes almost round; 84-100% were distorted by mature schizonts, altho hypertrophy was slight. Host cell nuclei were occasionally slightly distorted (8-10%), usually becoming rounder; 20-72% were displaced laterally.

Gametocytes. Host cells were always distorted by gametocytes, and became hypertrophied to a slightly greater degree than cells parasitized by schizonts. About 4% of the nuclei were distorted, usually being more rounded. Host cell nuclei were usually displaced (84-88%).

Two of the 11 Sasardi Mabuya were infected with a 2nd malarial parasite, similar to the condition reported by Lainson and Shaw (9) for Brazilian skinks. Lainson and Shaw assigned their 2nd parasite to *Plasmodium tropiduri*. However, I cannot fit this 2nd parasite from Panamanian skinks into a known species, and must accordingly consider it to be undescribed. In reference to the globular

Figs. 31-41. Asexual stages of *Plasmodium diploglossi* in erythrocytes.
Fig. 31. Trophozoite.
Fig. 32-41. Nearly mature schizonts and segmenters.
Figs. 42-46. Gametocytes of *P. diploglossi* in erythrocytes.
Figs. 42-43. Microgametocytes.
Figs. 44-46. Macrogametocytes.
Figs. 47-57. Asexual stages of *Plasmodium morulum* sp. nov.
Fig. 47. Trophozoite in late normoblast.
Fig. 48. Young schizont in proerythrocyte.

Figs. 49-52. EE-schizonts in thrombocytes (49, 50) and lymphocytes (51, 52).
Figs. 53-57. Schizonts in proerythrocytes.
Fig. 54. Double infection of *P. morulum* schizont and immature schizont of *P. diploglossi* in proerythrocyte.
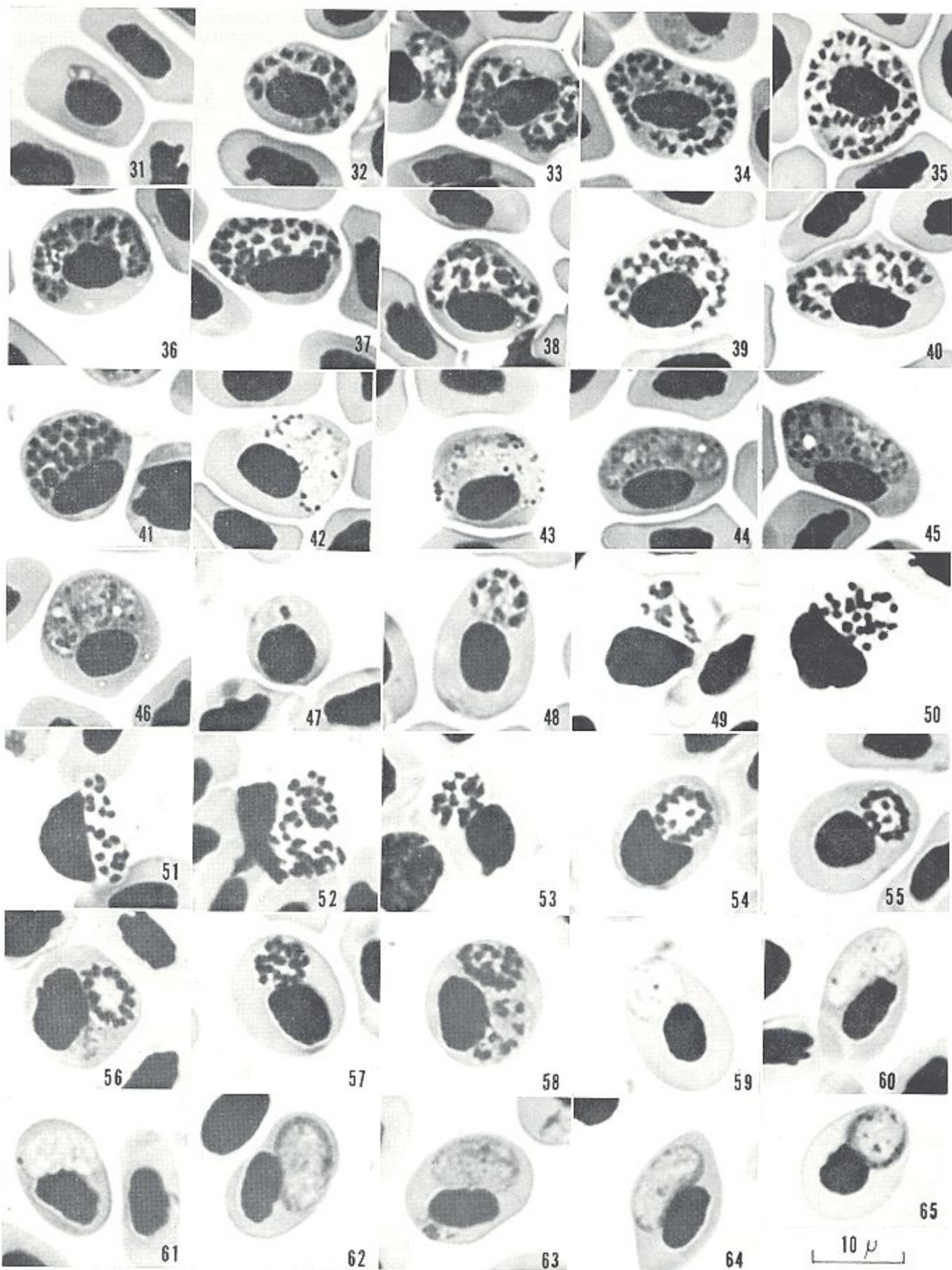Figs. 59-65. Gametocytes of *P. morulum*.
Figs. 59-60. Microgametocytes in erythrocytes.
Fig. 61. Microgametocyte in proerythrocyte.
Figs. 62-64. Macrogametocytes in proerythrocytes.
Fig. 65. Macrogametocyte in erythrocyte.

10 μ

mass of nuclei usually formed in mature schizonts, I designate it:

Plasmodium morulum sp. nov.

DIAGNOSIS: A species of Plasmodium usually parasitic in immature erythrocytes, in which pigment is scarce, if present at all. Minute dark granules occasionally seen in some stages did not give the polarized light test for hemozoin. The oval to round schizonts contained 14-40 nuclei, usually arranged in a globular mass. Schizonts appeared in abundance in white cells following inoculation of infected blood into clean hosts. Gametocytes were lenticular or oval to round, usually polar in position. Host cells were slightly hypertrophied and distorted, and their nuclei were usually displaced.

DESCRIPTION: *Trophozoites*. The youngest stages were squarish, 1.5 by 1, with no obvious cytoplasm (Fig. 47). As the parasite reached a size of 3 by 2, the nucleus and cytoplasm appeared equal in volume, and the parasite's shape was roughly oval. No vacuole was formed. Trophozoites might occupy any portion of the host cell cytoplasm.

Schizonts. Binucleate schizonts were 3.5-4 by 2-3, oblong with blunt ends. No cytoplasmic projections were seen. The nuclei stained deep red and the cytoplasm pale blue. As nuclear division proceeded, the schizonts become rounder and usually polar in position (Fig. 48). The mature schizonts were usually rounded or nearly so, with the merozoites arranged densely along the periphery (Figs. 53-57). A rosette was sometimes formed, (Figs. 54, 55) but the center of the schizont might be empty (Fig. 56). Schizonts often formed a globular mass of nuclei (Figs. 53, 57). They were 5-7 by 3-5, with a mean of 5.6 by 4.5. The number of nuclei in apparently mature schizonts was 14-40, with a mean of 17.6 (N:55).

Gametocytes. Gametocytes were bean-shaped to round (Figs. 59-65), usually (88%) polar in position. Macrogametocytes stained deep blue; their nuclei were indicated by an irregular reddish area in the middle and toward one side of the parasite. Microgametocytes were pale or pinkish, occasionally with diffuse nuclear material. Gametocytes were 5-10 by 4-7, with a mean of 6.8 by 5.1. There was some suggestion of an increase in size with age: 25 apparently mature gametocytes were from 5-7 by 4-6 with a mean of 6.0 by 5.0 during the early stages of one infection. Two months later, when asexual stages were declining in abundance, gametocytes were 6-10 by 4-7 with a mean of 7.6 by 5.1.

There was no trace of pigment in the younger asexual stages. In 8% of the schizonts and 20% of the gametocytes, tiny dark granules could be detected with difficulty. No refractility appeared upon examination with polarized light, and the exact nature of the granules awaits further study.

Exoerythrocytic stages. Schizonts were commonly seen in lymphocytes (16%) (Fig. 51, 52) and thrombocytes (84%) in one natural infection (Fig. 49, 50). They contained 7-22 nuclei. Schizonts in white cells appeared early, were abundant, and persisted thruout the active

phase in experimental infections. In one experimental infection EE-schizonts had 18-24 nuclei and parasitized only lymphocytes.

Types of host cells parasitized. In the single acute natural infection studied, young asexual stages were found only in normoblasts (40%) and proerythrocytes (60%). Schizonts parasitized predominantly proerythrocytes (98%) or rarely erythrocytes. Gametocytes were found in both proerythrocytes (72%) and erythrocytes (28%). As schizonts decreased in abundance in this infection, P. diploglossi asexual stages appeared. The host died with massive parasitemia of both species before P. diploglossi gametocytes became common. In an experimental infection, schizonts parasitized both proerythrocytes (77%) and erythrocytes (23%).

Effects upon host cells. Young asexual stages had no discernible effects upon host cells. Schizonts usually (87%) caused some distortion of the proerythrocytes and displacement of their nuclei, but did not distort the host cell nuclei. Gametocytes caused some hypertrophy of erythrocytes, with increase in the lateral dimension, and a slight increase in the width of the host cell nuclei. Almost all (98%) infected cells were distorted, and most host cell nuclei (87%) were displaced.

TYPE HOST: *Mabuya mabouya* (Lacépède) (Sauria, Scincidae).

TYPE LOCALITY: Sasardi, San Blas Territory, Republic of Panama.

GEOGRAPHIC RANGE: Known only from the type locality.

LOCATION OF TYPES: The series of type slides is retained at present in my collection. Paratypes are deposited in the Dept. of Zoology, Univ. of California, Los Angeles and with Professor P. C. C. Garnham, Imperial College Field Station, Silwood Park, England.

DISCUSSION

Eight species of the subgenus *Sauramoeba* Garnham, 1966 have previously been described from New World lizards: *cnemidophori, diploglossi, floridense, mexicanum, tropiduri, beltrani, brumpti,* and *balli*. P. beltrani and P. brumpti are probably closely related to P. mexicanum; none of these 3 has been reported south of Mexico (12, 13, 14). *Plasmodium floridense* was reported from the southeastern United States (6, 8, 15) and from the mountains of extreme western Panama (7). It is common in the Panamanian lowlands also, down to the Colombian border; its distribution and variation will be described in a later paper. P. balli is thus far known only from Panama (16). P. cnemidophori has been reported only from Brazil (3, 9), as have P. tropiduri and P. diploglossi (1, 9).

P. gonatodi is the first Plasmodium species to be described from a geckonid lizard. In both gametocyte and schizont appearance, P. gonatodi resembles P. cnemidophori, P. beltrani, and P. balli, and its schizonts alone are

similar to those of *P. diploglossi*. Prominent pigment masses or granules are present in both schizonts and gametocytes of all these except *P. balli* and *P. gonatodi*. Both *P. cnemidophori* and *P. balli* usually produce more merozoites than does *P. gonatodi*. Schizont shape is far less constant in *P. gonatodi* than in the other species with which it might be confused. The sharp pointed ends of young gametocytes and the large and peculiarly shaped prematuration stages of gametocytes are completely distinctive of *P. gonatodi* from other New World saurian malarias.

Panamanian *P. diploglossi* differ from Brazilian *diploglossi* by rarity of the tendency of either schizonts or gametocytes to encircle the host cell nucleus, and by the production of lenticular to oval, rather than elongated gametocytes. It would appear that fewer merozoites are produced by the Panamanian strain, 11-40, in contrast to more than 40 (1) and 40-50 (9), in Brazil. Aragão and Neiva (1) described pigment in their parasites as dark brown, and Lainson and Shaw (9) as dark greenish-yellow in schizonts and dark in gametocytes; the Panamanian *diploglossi* has golden yellow pigment in asexual stages, and nearly black pigment in gametocytes. In mixed infection with *P. morulum* in Panamanian skinks, *P. diploglossi* is easily distinguished by the constant presence of prominent pigment masses or granules in all stages past the uninucleate, and the apparent absence of pigment at any stage of *P. morulum*. The non-curved schizonts commonly seen in Panamanian *P. diploglossi* resemble at times those of *P. gonatodi*, but again the species may be distinguished by the prominence of pigment in *diploglossi* and its apparent absence in *gonatodi*.

P. morulum schizonts appear distinct from those of the other New World sauramoebas except for occasional schizonts of *P. diploglossi*. Again, the apparent absence of pigment in *P. morulum* is sufficient for diagnosis. Gametocytes resemble the rounded form of *P. floridense* and *P. tropiduri*, but both of these species, as well as the *mexicanum* group are prominently pigmented. The schizonts contain, on the average, nearly 3 times as many nuclei (17.6) as do those identified as *P. tropiduri* in Brazilian skinks by Lainson and Shaw (6.2).

Panamanian skinks identified here as *Mabuya mabouya* may or may not be conspecific with the skinks examined in Brazil by Lainson and Shaw. The names *M. mabouya* and *M. agilis* have both been in common use for Brazilian and Panamanian skinks. C. W. Myers informed me (personal correspondence) that it is impossible at present to make any definite conclusion concerning the taxonomic status of these populations.

It is possibly significant that Lainson and Shaw in Brazil, and I in Panama, have each encountered 2 species of *Plasmodium* in what may be the same, widely ranging species of host. The Panamanian *diploglossi* show some fairly good differences in taxonomic characters from Brazilian *diploglossi*, as mentioned above. *Plasmodium morulum* is quite similar to what was called *P. tropiduri* in Brazilian skinks by Lainson and Shaw, but differs in

having over twice as many merozoites, with resultant difference in schizont appearance, and in the apparent absence of pigment. The latter condition may be related to parasitization of immature erythrocytes by *P. morulum*, but it extends to those gametocytes present in erythrocytes, as well. I gather that Lainson and Shaw's parasite was found primarily in erythrocytes, altho they made no clear statement to this effect.

Despite reports of 2 saurian *Plasmodium* species infecting hosts of different families (*P. minasense, P. diploglossi*), there is little indication that saurian malarial parasites have the same broad capacity to infect species belonging to different families that their avian congeners clearly possess. There is not one shred of direct experimental evidence to suggest that saurian malarial parasites can cross family lines. The most plastic saurian *Plasmodium* so far studied is *P. mexicanum*, and altho Thompson and Huff (14) were able to get cross-generic infections, they were within the family Iguanidae. The only infections they obtained which resembled the course described in natural hosts by Pelaez et al. (13) were within the same host genus as the natural hosts, *Sceloporus*. *P. mexicanum* is clearly different in at least one aspect of its biology from other saurian malaria parasites studied (*P. floridense*, 15; *P. sasai*, 17, 18). It readily produces E.E.-stages in fixed cells by blood inoculation. Further evidence of *P. mexicanum*'s distinctiveness may be its capacity to complete sporogony in phlebotomine sandflies (2).

Consequently, such identifications as those of *Plasmodium minasense* in *Mabuya agilis* (Scincidae) in Brazil (4), in *Iguana nudicollis* (Iguanidae), in Guiana (11), and in *Gonyocephalus borneensis* (Agamidae) in Malaysia (10), seem dubious to me and in need of experimental verification before generalities are made concerning them. This is a minute parasite, with only 4 merozoites, and obviously provides little opportunity for structural variation to occur. In addition, there are discrepancies in the accounts of its gametocytes (10) which may be of taxonomic significance. Lainson and Shaw's (9) report of *P. cnemidophori* in *Ameiva ameiva*, on the other hand, seem quite reasonable, since both *Ameiva* and *Cnemidophorus lemniscatus*, the type host, are teiid lizards. Their identification of the Brazilian skink parasite as *P. diploglossi* is justified, for the structural similarities are quite strong, despite the phylogenetic difference between scincid and anguid lizards (*Diploglossus fasciatus*, the type host, is an anguid). It would be interesting, tho, to see the results of inoculating their *P. tropiduri* of skink origin into *Tropidurus torquatus*, type host for the species, and an iguanid. Careful experimental studies to determine the degree of host specificity of several more saurian malaria species would be a valuable contribution to our understanding of these host-parasite relationships.

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