

A Malaria Parasite, *Plasmodium aurulentum* sp. nov.  
from the Neotropical Forest Gecko  
*Thecadactylus rapicaudus*

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## A Malaria Parasite, *Plasmodium aurulentum* sp. nov. from the Neotropical Forest Gecko *Thecadactylus rapicaudus*

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**SYNOPSIS.** *Plasmodium aurulentum* sp. nov. from the neotropical forest gecko *Thecadactylus rapicaudus* in Panama is characterized by oval or round to lenticular gametocytes, 6-22

nuclei in crudely fan-shaped schizonts, and light golden pigment masses. A prominent, pinkish red-staining mass, present in older schizonts, disappears by the time schizonts reach maturation.

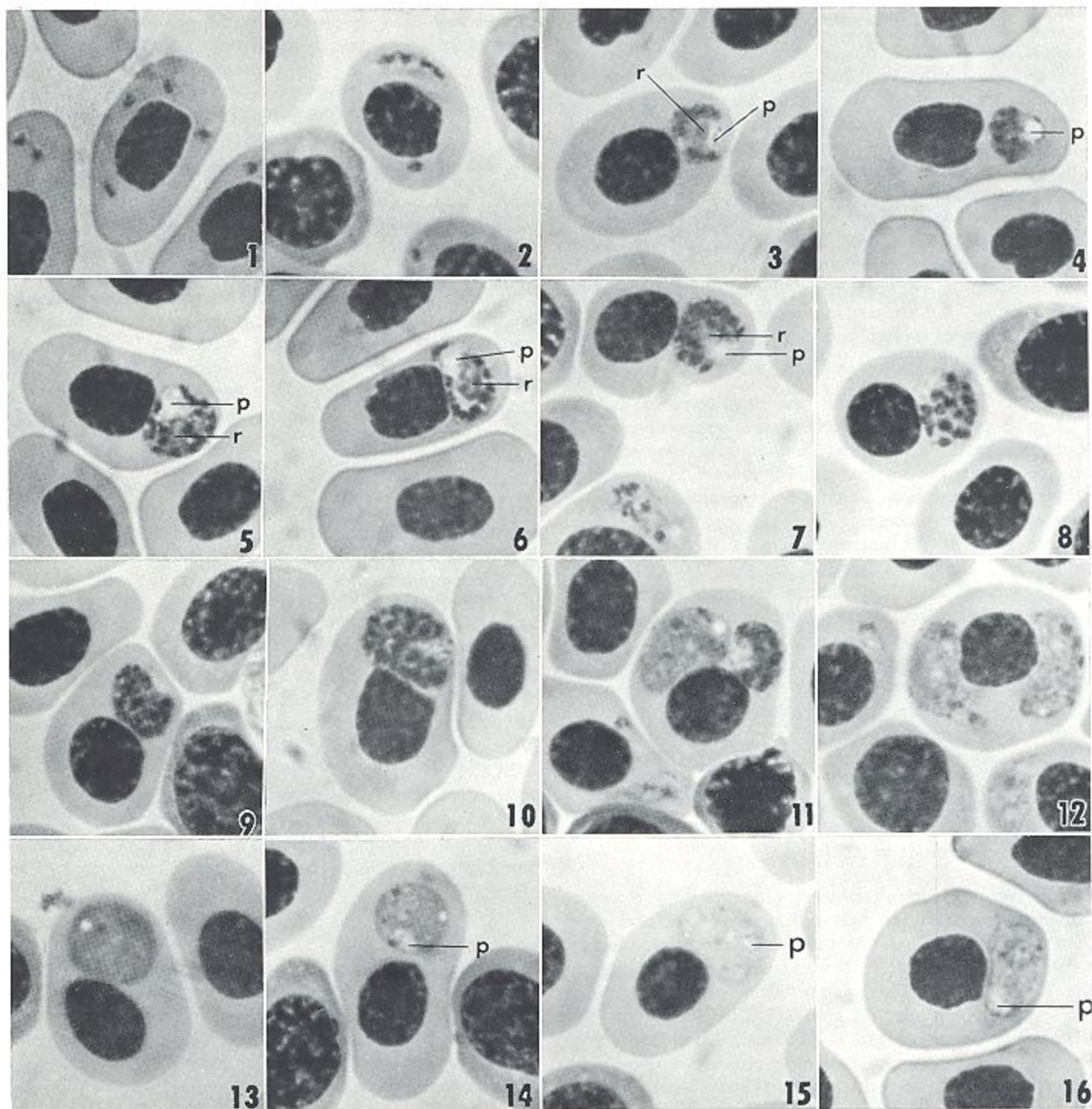
**D**URING continuing studies on the parasitology of neotropical reptiles, a number of new haemosporidia have been encountered (1, 2). The present report describes another species of saurian malaria parasite from Panama, and extends the host range of the genus *Plasmodium* into the family Gekkonidae.

Eight of a series of 24 neotropical forest geckoes *Thecadactylus rapicaudus*, collected in central and eastern Panama in 1968 and 1969, were found infected with a *Plasmodium* which cannot be assigned to any known species.

### MATERIALS AND METHODS

Geckoes were collected in the jungle by hand or noose and brought alive to Gorgas Memorial Laboratory for examination. Thin blood smears were obtained by clipping toes or by piercing

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*Plasmodium aurulentum* sp. nov. from *Thecadactylus sapicaudus*

1. Trophozoites. 2. Early trophozoite and 4-nucleate schizont. 3-6. Immature schizonts. 7-10. Mature or nearly mature schizonts.

11. Mature schizont and ♀ gametocyte. 12-14. ♀ gametocytes. 15, 16. ♂ gametocytes.

Host cells in Figs. 1-10, proerythrocytes; remainder, erythrocytes. p = pigment; r = red-staining mass.

one of the blood vessels in an upper foreleg with a needle. Infected lizards were followed, often for several months, by making blood smears at approximately weekly intervals. Smears were fixed in absolute methanol and stained by Giemsa or Giemsa-May-Grunwald techniques. Parasites were studied and photographed at 1000 × under oil immersion. Measurements were made with ocular micrometer and are recorded in micra. Student's *t* test was used for statistical comparison of means. The descrip-

tion below is based upon 3 acute natural infections. Elsewhere (3) I have defined an acute infection of saurian malaria as the initial period of patency, or a recrudescence, during which multiply-infected cells are present.

## RESULTS

In reference to the delicate, light golden hue of its pigment, I designate this distinctive species.



*Plasmodium aurulentum* sp. nov.

**DIAGNOSIS.** A malaria parasite of forest geckoes distinguished by the combination of light, golden pigment masses in the multinucleate asexual stages and in gametocytes; presence of 6-22 nuclei in apparently mature, crudely fan-shaped schizonts; and oval or round- to bean-shaped gametocytes. Older schizonts contain a prominent, pinkish red-staining mass which diminishes in size and usually disappears as nuclear division continues.

**DESCRIPTION.** *Trophozoites.* The earliest stages (Fig. 2) are triangular or squarish,  $1.5 \times 1$ , with a thin edge of pale blue cytoplasm. A small vacuole appears early (Fig. 1) but usually disappears by the first nuclear division. Pigment is often present in the larger trophozoites, which are usually somewhat elongate.

*Schizonts.* The smallest binucleate stage seen was  $5 \times 2$ . One or 2 cytoplasmic projections are commonly seen in young schizonts. As nuclear division proceeds, schizonts become roughly fan-shaped with 1-3 rows of tightly packed nuclei at the periphery. Nuclei never completely ring the schizont to form rosettes. The pigment granules form a large mass at the narrower side of the schizont, occasionally forming a "handle" to the "fan." Pigment masses, present in 98% of mature schizonts observed, are a delicate gold color, often so light as to give the appearance at first of a vacuole (Figs. 3-7). A prominent mass of pinkish red-staining material, lighter in shade than the nuclei, is often present in schizonts with 8 or more nuclei (Figs. 3, 5-7). This mass diminishes in size as nuclear division continues, and usually disappears in the largest schizonts. Apparently mature schizonts (Figs. 8-11) contain 6-22,  $\bar{x}$  13.1 nuclei ( $N = 78$ ). Schizonts in erythrocytes contain 8-16,  $\bar{x}$  11.1 nuclei while those parasitizing proerythrocytes have 6-11,  $\bar{x}$  15.1 nuclei. The difference is highly significant ( $t = 2.8182$ ,  $p \leq 0.01$ ).

*Gametocytes.* Young gametocytes are slightly elongate, rather flattened on the host cell nucleus side, and often with irregular outlines. As they reach maturity, they assume a round or oval to broadly bean-shaped configuration (Figs. 11-16). There is no difference in size between sexes; gametocytes are 6-11 by 4-9,  $\bar{x}$  7.7 by 6.1 ( $N = 80$ ). Macrogametocytes (Figs. 11-14) stain deep blue with Giemsa; the compact, red-staining nucleus is not always easily detected. Microgametocytes (Figs. 15-16) are pale to deep pink, with diffuse nuclei. Pigment, observed in 95% of gametocytes, is golden, often so light as to be easily overlooked, and usually forms an elongate, compact narrow mass in the center of the gametocyte. Occasionally, smaller clumps or dots of pigment are scattered throughout the cytoplasm without aggregating into a central mass. These granules of pigment may appear black or very dark brown. Spherical vacuoles are commonly seen in gametocytes (Figs. 11, 13, 14).

*Exoerythrocytic stages.* No schizonts definitely known to represent this species were observed in cells outside the erythrocyte series. No EE-stages were seen in sections of

liver, lung, brain, spleen, heart, kidney or intestine, or in bone marrow smears.

*Types of host cells parasitized.* Small uninucleate parasites in 2 infections were found mostly in proerythrocytes (82 and 75%) and erythrocytes. In one infection, 2% were in erythroblasts. Mature schizonts in 3 infections were found in proerythrocytes (78%) and erythrocytes, while gametocytes were usually in erythrocytes (81%) or proerythrocytes.

*Effects upon host cells.* Small asexual parasites have no discernible effect upon host cells. Large schizonts, always polar in position, cause a slight hypertrophy of both the host cell and its nucleus, most noticeable in the breadth of cell and nucleus. There is some distortion of host cell (48%) and nucleus (35%) but less frequent displacement of the nucleus (17%). Gametocytes, usually polar in position (98%), produce no hypertrophy of host cell or nucleus, but do cause a slight rounding of both, with increases in their widths and slight decreases in their lengths, in comparison to uninfected cells. Host cells containing gametocytes are often distorted (63%), their nuclei less frequently so (38%). Nuclei are commonly displaced (41%) in cells containing gametocytes.

**TYPE HOST.** *Thecadactylus rapicaudus* (Houttuyn) (Sauria, Gekkonidae).

**TYPE LOCALITY.** Boy Scout Camp Chagres, Madden Lake, Canal Zone.

**GEOGRAPHIC RANGE.** San Blas Territory, Colon and Panama provinces, Republic of Panama, and the Canal Zone.

**LOCATION OF TYPES.** The series of type slides is retained at present in the collection of the author. 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

*Plasmodium aurulentum* is not likely to be confused with any of the 16 other saurian malaria parasites now known from the New World. *Plasmodium minasense* Carini and Rudolph, *P. tropiduri* Aragão and Neiva, *P. rhadinurum* Thompson and Huff, *P. basilisci* Pelaez and Perez-Reyes, *P. torrealbai* Scorza and Dagert, and *P. pifanoi* Scorza and Dagert all have schizonts with 12 or fewer nuclei at maturity. *P. diploglossi* Aragão and Neiva, *P. cnemidophori* Carini, *P. gonatodi* Telford, *P. balli* Telford, and *P. beltrani* Pelaez and Perez-Reyes have elongate gametocytes. *P. chiricahuae* Telford has the unique combination of huge rounded gametocytes and small schizonts. Of those species with round or oval gametocytes, *P. mexicanum* Thompson and Huff and *P. brumpti* Pelaez and Perez-Reyes have large, dark pigment granules in both schizonts and gametocytes; the former commonly produces schizonts in white cells as well as in erythrocytes. *P. morulum* Telford seems to lack pigment at any stage, and usually has schizonts in lymphocytes and thrombocytes

during the acute phase. *P. aurulentum* is readily distinguished from *P. floridense* Thompson and Huff by having lighter golden pigment and by never having nuclei arranged as rosettes in the schizonts. It appears unique among the New World saurian malarias by the presence of a pinkish red-staining mass in older schizonts which disappears as nuclear division becomes complete.

With description of this species, the genus *Plasmodium* is now known from the following families of lizards: Gekkonidae, Sphaerodactylidae, Iguanidae, Agamidae, Chamaeleontidae, Lacertidae, Teiidae, Scincidae, Anguillidae, Cordylidae, and Varanidae.

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