

PROTOZOAN PARASITES OF THE BUFONINAE
(AMPHIBIA)¹

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From a study of collected material and a survey of the literature, records are available as to the protozoan fauna of 54 species of toads belonging to the Bufoninae (53 species of *Bufo* and 1 of *Nectophryne*). A number of conclusions have been derived from this study.

1. Examples from all of the major areas of distribution of *Bufo* are represented—in some cases by abundant material (*Bufo* is not recorded from Australia).
2. The protozoan fauna of at least one of the more common species from each continent have been studied extensively.
 - (a) Africa, *Bufo regularis*—32 spp. of protozoa
 - (b) Asia, *Bufo melanostictus*—47 spp.
 - (c) Europe, *Bufo bufo*—26 spp.
 - (d) N. America, *Bufo americanus*—17 spp.
 - (e) S. America, *Bufo marinus*—23 spp.
3. (a) 45 species of protozoa have been reported from African hosts.
 - (b) 62 species have been reported from Asia and the adjacent islands of Borneo, Japan, Java, Philippines, Sumatra, etc.
 - (c) 44 species have been reported from Europe.
 - (d) 50 species have been reported from North America.
 - (1) 40 species from Canada and the U. S. A.
 - (2) 5 species from Mexico, Cuba, and Porto Rico.
 - (3) 12 species from Central America.

(A number of the same species occur in all three areas.)
 - (e) 32 species have been reported from South America (mainly Brazil).
4. A total of 4 genera and over 200 species of protozoa have been reported.
5. The genera *Cepedea* (19 spp.), *Opalina* (35 spp.), *Protoopalina* (14 spp.), and *Zelleriella* (22 spp.) of the Opalinidae as well as *Balantidium* (11 spp.), *Nyctotherus* (7 spp.), and *Trypanosoma* (20 spp.) seem to be the most widely distributed and the most common protozoan forms.
6. *Trichomonas augusta* and *Trypanosoma rotatorium* seem to be the most nearly cosmopolitan species in their distribution.
7. The reported occurrence of *Nyctotherus cordiformis* from other than European hosts probably represents errors in specific identifications.
8. A number of new combinations are made in the nomenclature.
 - (a) *Trichomastix* sp? of Dobell, 1910 is referred to the genus *Eutrichomastix* as recently defined by Kofoid.
 - (b) *Trichomastix* sp? of Fantham, 1924 and *T. sp?* of Fantham, 1931 are similarly transferred to *Eutrichomastix*.

¹ Contribution from the Biological Laboratories of Knox College, No. 114.

- (c) *Herpetomonas xenopi* Fantham, 1922, and *H. sp?* of Fantham, 1931 are transferred to the genus *Leishmania* to accord with the transfer of other amphibian herpetomonads recently announced.
- (d) *Zschokkella prashadi* Ray, 1933 is declared a *nomen nudum* inasmuch as neither description nor figures have accompanied the original designation of the species.
9. A strong probability exists that *Opalina obtrigonoidea* Metcalf, 1923 is identical with *O. triangularis* Ghosh, 1918. In such case the various subspecies and varieties of *O. obtrigonoidea* should be referred to *O. triangularis* and should therefore become respectively, *O. triangularis americana* (Metcalf), *O. t. americana rugosa* (Met.), *O. t. austriaca* (Met.), *O. t. japonica* (Hara), *O. t. lata* (Met.), *O. t. maxima* (Met.), *O. t. orbiculata* (Met.), *O. t. plicata* (Met.), and *O. t. rugosa* (Met.).
10. The criteria used by Metcalf and others in the subdivision of certain of the species of the Opalinidae do not seem to be definite enough to enable other workers to recognize all of the varietal forms thus established (in many cases on the basis of study of poorly preserved material taken from preserved host specimens). The species designations seem to be valid, but doubt exists as to the validity of many of the subspecies and varieties reported. A host difference within the range of a limited area is of doubtful value in establishing subspecies when morphological differences in the parasite are impossible to catalog.

The following list includes the hosts and parasites used as a basis for drawing the above conclusions.

1. BUFO AMERICANUS (Canada, U. S. A.)
 1. Haemoproteus lanoraiea
 2. H. laurentiae
 3. H. lavalia
 4. Haptophrya michiganensis
 5. Karotomorpha swezyi
 6. Leptotheca ohlmacheri
 7. Nyctotherus (?) cordiformis
 8. Opalina obtrigonoidea americana
 9. O. obtrig. amer. rugosa
 10. Phacus sp? of Hegner
 11. Plasmodium bufonis
 12. Trichomonas augusta
 13. Trypanosoma gaumontis
 14. T. inopinatum
 15. T. lavalia
 16. T. montrealis
 17. T. rotatorium
2. BUFO AMERICANUS COPEI (Canada)
 1. Balantidium sp? of Metcalf
 2. Opalina discophrya
3. BUFO ANDERSONII (Africa)
 1. Haptophrya gigantea
4. BUFO ANGUSTICEPS (Africa)
 1. Protoopalina gariensis
5. BUFO ARENARUM (S. America)
 1. Myxidium immersum
 2. Nyctotherus (?) cordiformis
 3. Trichomonas batrachorum
 4. Zelleriella antilliensis
 5. Z. antunesi
 6. Z. uruguayensis
6. BUFO ASPER (S. E. Asia)
 1. Cepedea siamensis
7. BUFO BOREA? (Canada, U. S. A.)
 1. Balantidium sp? of Metcalf
 2. Opalina obtrigonoidea maxima
8. BUFO BOREAS HALOPHILUS (U. S. A.)
 1. Opalina intermedia
 2. O. obtrigonoidea maxima
 3. Trichomonas augusta
9. BUFO BUFO (Europe)
 1. Balantidium entozoon
 2. Cepedea huergeri
 3. C. dimidiata
 4. Chilomastix caulleryi
 5. Chlamydomyrus stercora
 6. Copromonas subtilis
 7. Eimeria transcaucasia

8. *Entamoeba currens*
9. *E. ranarum*
10. *Hexamita intestinalis*
11. *Isospora* sp? of Wenyon
12. *Karotomorpha bufonis*
13. *Leptomonas jaculum* (experimental)
14. *Monocercomonas rotunda*
15. *Nyctotherus cordiformis*
16. *Opalina cincta*
17. *O. ranarum*
18. *Plistophora bufonis*
19. *Retortomonas dobelli*
20. *Trichomonas augusta*
21. *T. batrachorum*
22. *T. granulosa*
23. *Trimitus parvus*
24. *Trypanosoma rotatorium*
25. *T. sp?* of Grassi
26. *T. sp?* of Laveran and Mesnil
10. **BUFO BUFO ASIATICUS** (E. Asia)
 1. *Opalina asiatica*
 2. *O. bufoxena*
 3. *Protoopalina axonucleata*
 4. *P. hexasoma*
11. **BUFO BUFO FORMOSUS** (Japan)
 1. *Cepedea fujienensis*
 2. *Opalina japonica*
12. **BUFO BUFO JAPONICUS** (Japan)
 1. *Protoopalina hexasoma*
13. **BUFO CALAMITA** (Europe)
 1. *Entamoeba ranarum*
 2. *Hexamita parva*
 3. *H. sp?* of Kofoid, McNeil, and Bonestall
 4. *Mastigamoeba hylae*
 5. *Protoopalina caudata*
 6. *P. intestinalis*
 7. *Syndyomita neglecta*
 8. *Trichomonas augusta*
 9. *T. batrachorum*
 10. *T. granulosa*
14. **BUFO CARENS** (Africa)
 1. *Eutrichomastix* sp? (Fantham)
 2. *Leishmania* sp? (Fantham)
 3. *Protoopalina octomixa*
 4. *P. viridis*
15. **BUFO CELEBENSIS** (Celebes Is.)
 1. *Cepedea celebensis*
16. **BUFO COGNATUS** (U. S. A.)
 1. *Opalina discophrya*
 2. *O. sp?* of Trowbridge and Hefley
 3. *Trichomonas augusta*
 4. *Zelleriella hirsuta*
17. **BUFO COMPACTILIS** (U. S. A.)
 1. *Balantidium* sp? of Metcalf
 2. *Nyctotherus* sp? of Metcalf
 3. *Opalina spiralis*
4. *Trichomonas augusta*
5. *Trypanosoma rotatorium*
18. **BUFO CONIFERUS** (Cent. America)
 1. *Balantidium* sp? of Metcalf
 2. *Zelleriella opisthocarya*
19. **BUFO CRUCIFER** (S. America)
 1. *Zelleriella antunesi*
 2. *Z. antunesi quadrata*
 3. *Z. uruguayensis*
20. **BUFO CRUENTATUS** (Java)
 1. *Balantidium* sp? of Metcalf
21. **BUFO DIVERGENS** (Borneo)
 1. *Cepedea celebensis*
22. **BUFO D'ORBIGNYI** (S. America)
 1. *Myxidium immersum*
 2. *Nyctotherus* (?) *cordiformis*
 3. *Trichomonas batrachorum*
 4. *Zelleriella antilliensis*
 5. *Z. antunesi*
 6. *Z. uruguayensis quadrata*
23. **BUFO FOWLERI** (U. S. A.)
 1. *Balantidium* sp? of Metcalf
 2. *Hexamita intestinalis*
 3. *Nyctotherus* (?) *cordiformis*
 4. *Opalina obtrigonoidea*
 5. *O. obtrig. americana*
 6. *O. obtrig. amer. rugosa*
 7. *O. obtrig. plicata*
 8. *O. obtrig. rugosa*
 9. *O. (?) triangularis*
 10. *O. triangulata*
 11. *O. virguloidea*
 12. *O. spp?* of Brandt
 13. *Trypanosoma rotatorium*
24. **BUFO GARGARIZANS** (China)
 1. *Cepedea buergeri sinensis*
25. **BUFO HAEMATITICUS** (Cent. America)
 1. *Balantidium* sp? of Metcalf
 2. *Cepedea dolichosoma*
 3. *Opalina* sp? of Metcalf
 4. *Zelleriella bufoxena*
26. **BUFO INTERMEDIUS** (Mexico)
 1. *Zelleriella intermedia*
27. **BUFO JERBOA** (Borneo)
 1. *Cepedea borneonensis*
28. **BUFO LEMUR** (Porto Rico)
 1. *Zelleriella microcarya*
29. **BUFO MACROTIS** (India)
 1. *Balantidium amygdali*
 2. *Cepedea sialkoti*
 3. *Nyctotherus reniformis*

30. BUFO MARINUS (Cent. and S. America, and Zool. Gardens, England)
1. Balantidium sp? of Kulo
 2. Dactylosoma ranarum
 3. Haemogregarina aguai
 4. H. bufo-marinus
 5. H. cayennensis
 6. H. darlingi (?) =
 7. H. sp? of Darling
 8. H. sp? of Franca
 9. H. sp? of Plimmer
 10. H. spp? of Wenyon (Eng.)
 11. Lankesterella sp? of Wenyon (Eng.)
 12. Myxidium immersum
 13. M. lindoyense
 14. Nyctotherus (?) cordiformis
 15. N. tejera
 16. Opalina sp? of Pearse
 17. Saccamoeba renacuajo
 18. Trichomonas augusta
 19. T. vitali
 20. Zelleriella antilliensis
 21. Z. antunesi
 22. Z. artigasi
 23. Z. opisthocarya
 24. Z. paulista
 25. Z. sp? of Chen and Stabler
31. BUFO MAURITANICUS (Africa)
1. Haemogregarina tunisiensis
 2. Protoopalina caudata
 3. P. intestinalis
 4. Trypanosoma bocagei
 5. T. rotatorium
32. BUFO MELANOSTICTUS (S. E. Asia)
1. Balantidium bicavata
 2. B. sp? of Chakravorti
 3. Cepedea dimidiata
 4. C. formosae (China)
 5. C. metcalfi
 6. C. pulchra javensis
 7. C. punjabensis
 8. C. seychellensis angusta
 9. C. subcylindrica
 10. C. virgula
 11. Discophrya sp? of Metcalf
 12. Eimeria laminata
 13. Eutrichomastix (?) batrachorum
 14. E. sp? of Dobell
 15. Haemogregarina boueti
 16. H. nucleobiseccans
 17. H. tonkinensis (China)
 18. H. sp? of Franca
 19. H. sp? of Houdemer
 20. H. sp? of Mathis and Leger
 21. H. sp? of Prowazek
 22. Hexamita sp? (of Dobell)
 23. Isospora wenyoni
 24. Nyctotherus (?) cordiformis
 25. N. papillatus
26. Opalina chattoni
27. O. coracoidea
 28. O. cora lahorensis
 29. O. minuta
 30. O. obtrigonoidea plicata
 31. O. plicata
 32. O. ranarum
 33. O. scalpriformis
 34. O. triangularis
 35. O. sp? of Bezenberger
 36. Protoopalina formosae (China)
 37. Toddia sp? of Mathis and Leger
 38. Trichomonas batrachorum
 39. T. sp? of Dobell
 40. Trypanosoma bocagei magna
 41. T. bocagei parva
 42. T. chattoni
 43. T. rotatorium
 44. T. sp? of Laveran and Mesnil
 45. Zelleriella macronucleata
 46. Zschokkella auerbachii
 47. Z. prashadi (*nomen nudum*)
33. BUFO MONKSIAE (Mexico)
1. Zelleriella opisthocarya
34. BUFO PARACNEMIS (S. America)
1. Trypanosoma butantanense (experimental)
 2. T. rotatorium
35. BUFO PELTACEPHALUS (Cuba)
1. Protoopalina sp? of Metcalf
 2. Zelleriella sp? of Metcalf
36. BUFO PHILIPPINICUS (Philippines)
1. Cepedea philippensis
37. BUFO POLYCERUS (=B. latifrons) (W. Africa)
1. Balantidium sp? of Metcalf
 2. Cepedea magna
38. BUFO PUNCTATUS (U. S. A.)
1. Opalina obtrigonoidea
 2. O. (?) triangularis
 3. Zelleriella sp? of Metcalf
39. BUFO QUADRIPORCATUS (Sumatra)
1. Cepedea philippensis
40. BUFO RADDEI (China)
1. Opalina pekinensis
 2. O. raddei
41. BUFO REGULARIS (Africa)
1. Entamoeba sp? of Fantham
 2. Eutrichomastix sp? (of Fantham)
 3. Giardia agilis (in tadpoles)
 4. Haemogregarina boueti
 5. H. froilano
 6. H. pestanae

7. *H. tunisiensis* (= *H. sp?* of Macfie)
 8. *H. sp?* of Balfour
 9. *H. sp?* of Bouet (?= *H. boueti*)
 10. *H. sp?* of Franca
 11. *H. sp?* of Plimmer
 12. *Leishmania xenopi* (Fantham, 1922)
 13. *Opalina sudafricana*
 14. *Protoopalina nutti*
 15. *P. regularis*
 16. *P. stevensoni*
 17. *P. transvaalensis*
 18. *P. sp?* of Metcalf
 19. *Toddia bufonis*
 20. *Trichodina bufonis*
 21. *Trichomonas batrachorum*
 22. *Trypanosoma bocagei magna*
 23. *T. bocagei parva*
 24. *T. inopinatum*
 25. *T. karyozekuton*
 26. *T. magna*
 27. *T. rotatorium*
 28. *T. somalense*
 29. *T. varani*
 30. *T. sp?* of Bouet
 31. *T. sp?* of Laveran and Mesnil
 32. *T. sp?* of Stevenson
42. **BUFO REGULARIS GUTTERALIS** (Africa)
 1. *Opalina sudafricana gutteralis*
43. **BUFO RETICULATUS** (Africa)
 1. *Trypanosoma rotatorium*
 2. *T. somalense*
 3. *T. sp?* of Laveran and Mesnil
44. **BUFO SMITHII** (Japan)
 1. *Opalina ranarum smithi*
45. **BUFO SPINULOSUS** (S. America)
 1. "Abibes" *sp?* of Escomel
 2. "Monadiens" *sp?* of Escomel
 3. *Nyctotherus sp?* of Escomel
 4. *Opalina ranarum*
 5. *Trichomonas augusta*
 6. *T. batrachorum* (in tadpoles)
 7. *T. "hominis"* of Escomel
 8. *Zelleriella sp?* of Metcalf
46. **BUFO STERNOSIGNATUS** (Mexico)
 1. *Zelleriella ovonucleata bufonis*
47. **BUFO TERRESTRIS** (U. S. A.) (= *B. lentiginosus*)
 1. *Cepedea obovoidea*
 2. *Leptotheca ohlmacheri*
 3. *Myxidium serotinum*
 4. *Opalina triangulata*
48. **BUFO TYPHONIUS** (Cent. America)
 1. *Opalina panamensis*
 2. *Zelleriella opisthocarya*
49. **BUFO VALLICEPS** (U. S. A.)
 1. *Balantidium sp?* of Metcalf
 2. *Leptotheca ohlmacheri*
 3. *Nyctotherus (?) cordiformis*
 4. *Opalina obtrigonoidea*
 5. *O. (?) triangularis*
 6. *Retortamonas dobelli*
 7. *Trichomonas augusta*
 8. *Zelleriella intermedia*
 9. *Z. intermedia cuneata*
50. **BUFO VARIEGATUS** (S. America)
 1. *Balantidium sp?* of Metcalf
51. **BUFO VIRIDIS** (Europe)
 1. *Cepedea dimidiata*
 2. *Opalina ranarum*
 3. *O. ranarum lata*
 4. *Protoopalina caudata*
 5. *Trichomonas batrachorum*
 6. *Trypanosoma rotatorium*
 7. *T. sp?* of Laveran and Mesnil
52. **BUFO WOODHOUSEI** (U. S. A.)
 1. *Balantidium sp?* of Metcalf
 2. *Opalina woodhousii*
 3. *O. sp?* of Trowbridge and Hefley
 4. *Zelleriella woodhousii*
 5. *Z. sp?* of Chen and Stabler
 6. *Z. sp?* of Metcalf
53. **BUFO spp?** (Europe)
 1. *Haemogregarina sp?* of Hoare
 2. *Isospora lieberkühni*
 3. *I. sp?* of Grassi
 4. *Lankesterella minima*
 5. *Nyctotherus amaniensis*
 6. *Trichodina urinicola*
 7. *Trichomonas mirabilis*
 8. *Trypanosoma sp?* of Stevenson
54. **NECTOPHRYNE HOSEI** (Borneo)
 1. *Cepedea hosei*