

REFERENCES

1. Allison, A. C. Protection afforded by sickle cell trait against subtertian malarial infection. *British medical journal*, 1: 290-297 (1954).
2. Allison, A. C. Malaria in carriers of the sickle cell trait and in newborn children. *Experimental parasitology*, 6: 417-447 (1957).
3. Allison, A. C. Polymorphism and natural selection in human populations. *Cold Spring Harbor symposia on quantitative biology*, 29: 137-149 (1964).
4. Ashkar, T. S., Cornille-Brogger, R., Storey, J., Nambiar, R. V. & Molineaux, L. ABO blood grouping of an indigenous population in rural northern Nigeria. Unpublished WHO Technical Note No. 29, MPD/TN/75.1, 64-68 (1975).
5. Bailey, N. T. J. *The mathematical theory of infectious diseases and its applications*. 2nd Ed. London, Griffin, 1975.
6. Beet, E. A. Sickle cell disease in the Balovale district of Northern Rhodesia. *East African medical journal*, 23: 75-86 (1946).
7. Bekessy, A., Molineaux, L. & Storey, J. Estimation of incidence and recovery rates of *Plasmodium falciparum* parasitaemia from longitudinal data. *Bulletin of the World Health Organization*, 54: 685-693 (1976).
8. Boyd, M. F. (ed.) *Malariaology*. Saunders, Philadelphia and London, 1949, 2 vols.
9. Brass, W., Coale, A. J., Demeny, P., Heisel, D. F., Lorimer, F., Romaniuk, A. & Van de Walle, E. *The demography of tropical Africa*. Princeton, Princeton University Press, 1968.
10. Bryceson, A. D., Fleming, A. F. & Edington, G. M. Splenomegaly in northern Nigeria. *Acta tropica*, 33: 185 (1976).
11. Brogger, S. Some demographic observations of births, deaths and migration in a rural area of Kano State, northern Nigeria. Unpublished WHO Technical Note No. 20, MPD/TN/74.1, pp. 35-45 (1974).
12. Brogger, S. & Cornille R. L. Precision and accuracy in the determination of immunoglobulin concentration in a large series of plasma specimens examined under field conditions. Unpublished WHO Technical Note No. 6, MEITN/72/1, pp. 45-59 (1972).
13. Brogger, S., Storey, J. & Thomas, D. Height of the children in the study population. Unpublished WHO Technical Note No. 1, ME/TN/72/1, pp. 14-16 (1972).
14. Brogger, S., Lietaert, P., Matsushima, T. & Ramos Camacho, E. Estimation of sprayable surfaces. Unpublished WHO Technical Note No. 2, ME/TN/72/1, pp. 17-23 (1972).
15. Bragger, S., Storey, J., Bekessy, A. Some observations on distribution of malaria parasites in thick blood films. Unpublished WHO Technical Note No. 10, MPD/TN/73.1, pp. 39-43 (1973).
16. Bruce-Chwatt, L. J. Problems of malaria control in tropical Africa, *British medical journal*, 1: 169-174 (1954).
17. Bruce-Chwatt, L. J. Parasite density index in malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 52: 389 (1958).
18. Bruce-Chwatt, L. J. Mathematical models in the epidemiology and control of malaria. *Tropical and geographical medicine*, 28: 1-8 (1976).
19. Bruce-Chwatt, L. J. & Archibald, M. Malaria control pilot project in western Sokoto, northern Nigeria: a report on four years' results. *Proceedings of the 6th International Congresses of Tropical Medicine and Malaria*, 7: 347-361 (1959).

20. Brun, L. O. Contribution à l'étude biologique et écologique des vecteurs majeurs de paludisme en Afrique de l'ouest. These, Université de Rennes, 1973.
21. Cao, A., Melis, M. A. & Galanello, R. Fetal haemoglobin and malaria. *Lancet*, 1: 202 (1977).
22. Carnevale, J., Frézil, M., Bosseno, M. F., Le Pont, F. & Lancien, J. Etude de l'agressivité d'*Anopheles gambiae* A en fonction de l'âge et du sexe des sujets humains. *Bulletin of the World Health Organization*, 56: 147-154 (1978).
23. Cavalié, Ph. & Mouchet, J. Les campagnes expérimentales d'éradication du paludisme dans le nord de la République du Cameroun. I. Les vecteurs de l'épidémiologie du paludisme dans le Nord-Cameroun. *Médecine tropicale*, 21: 846-869 (1961).
24. Cavalié, Ph. & Mouchet, J. Les campagnes expérimentales d'éradication du paludisme dans le nord de la République du Cameroun. II. Les opérations de lutte antipaludique et leurs résultats. *Médecine tropicale* 22: 95-118 (1962).
25. Cavalli-Sforza, L. L. & Bodmer, W. F. *The genetics of human populations*, San Francisco, Freeman, 1971, p. 137.
26. Choumara, R., Hamon, J., Ricosse, J. & Bailly, H. Le paludisme dans la zone pilote antipaludique de Bobo-Dioulasso (Haute Volta, A.O.F.) Première partie: Présentation de la zone pilote. Quatrième partie: Epidémiologie du paludisme dans les zones traitées ou non traitées. *Cahiers de l'ORSTOM*, No. 1, pp. 17-20, 99-105 (1959).
27. Coatney, G. R. Simian malarias in man: facts, implications and predictions. *American journal of tropical medicine and hygiene*, 17: 147-155 (1968).
28. Coatney, G. R., Collins, W. E., Warren, M. W. & Contacos, P. G. *The primate malarias*. US Department of Health, Education and Welfare, NIH, Bethesda, 1971.
29. Cohen, J. E. Heterologous immunity in human malaria. *Quarterly review of biology*, 48: 467-489 (1973).
30. Cohen, S. Immune effector mechanisms. In: Cohen, S. & Sadun, E. H. ed. *Immunology of parasitic infections*, Oxford, Blackwell, 1976. pp. 18-34.
31. Coluzzi, M., Sabatini, A. & Petrarca, V. Chromosomal investigations on species A and B of the *Anopheles gambiae* complex in the Garki district (Kano State, Nigeria)-results of species identification from 1971 to 1974. Unpublished WHO Technical Note No. 24, MPD/TN/75.1, pp. 16-25 (1975).
32. Coluzzi, M., Sabatini, A., Petrarca, V. & Di Deco, M. A. Behavioural divergencies between mosquitos with different inversion karyotypes in polymorphic populations of the *Anopheles gambiae* complex. *Nature*, 266: 832-833 (1977).
33. Cornille-Brogger, R. Titration of IgM antibodies to *Plasmodium falciparum* by the indirect fluorescent antibody test. Unpublished document WHO/MAL/77.886 (1977).
34. Cornille, R. L. & Brogger, S. Evaluation of veronal and phosphate buffered gelfoam for the detection of malaria precipitins by double diffusion test. Unpublished WHO Technical Note No. 3, ME/TN/72/1, pp. 21-23 (1972).
35. Cornille-Brogger, R. & Mathews, H. M. Field application to malaria studies of the passive haemagglutination (PHA) test with lyophilized cells. *Bulletin of the World Health Organization*, 52: 39-42 (1975).
36. Cornille-Brogger, R., Brogger, S., Storey, J. & Thomas, D. P. The precipitin test for malaria antibodies as applied in the immunological studies of project IR-0172. Unpublished WHO Technical Note No. 12, MPD/TN/73.1 pp. 50-56 (1973).
37. Cornille-Brogger, R., Storey, J. & Thomas, D. P. "S antigen-antibody" systems associated with *Plasmodium falciparum* infections in northern Nigeria. Unpublished WHO Technical Note No. 14, MPD/TN/73.1 pp. 65-68 (1973).

REFERENCES

38. Cornille-Brogger, R., Mathews, H. M., Storey, J., Ashkar, T. S., Bragger, S. & Molineaux, L. Longitudinal serological study of malaria in the rural west African Sudan Savanna, in relation to the application of control measures. I. Study design, parasitological situation and serological methods. Unpublished document WHO/MAL/76870 (1976).
39. Cornille-Brogger, R., Mathews, H. M., Ashkar, T. S., Storey, J. & Molineaux, L. Longitudinal serological study of malaria in the rural west African Sudan Savanna, in relation to the application of control measures. V. Follow-up after the period of malaria control. Unpublished document WHOMAL/77890 (1977).
40. Cornille-Brogger, R., Mathews, H. M., Storey, J., Ashkar, T. S., Bragger S., & Molineaux, L. Changing patterns in the humoral immune response to malaria, before, during and after the application of control measures: a longitudinal study in the West African Savanna. *Bulletin of the World Health Organization*, 56: 579-600 (1978).
41. Cornille-Brogger, R., Fleming, A. E., Kagan, I., Matsushima, T & Molineaux, L. Abnormal haemoglobins in the Sudan savanna of Nigeria. II. Immunological response to malaria in normals and subjects with sickle cell trait, *Annals of tropical medicine and parasitology*; 73: 173-183 (1979).
42. Detinova, T. S. *Age-grouping methods in Diptera of medical importance: with special reference to some vectors of malaria*, Geneva, World Health Organization Monograph Series No. 47, 216 pp. (1962).
43. Detinova, T. S. & Shidrawi, G. R. Observation on age determination of *A. gambiae* Giles S.L. and *A. funestus* Giles in the savanna zone, Kano, Nigeria. Unpublished WHO Technical Note No. 25, MPD/TN/75.1 pp. 26-36 (1975).
44. Diallo, S., Coulibaly, A. & Konaté, L. Effets de l'administration sulfadoxine-pyriméthamine sur l'accès palustre en zone d'hyperendémie. *Bulletin de la Société médicale d'Afrique noire de Langue française*, 21: 398-401 (1976).
45. Diallo, S., Coulibaly, A., Konaté, M. & Samba, O. Chimio-prevention à la chloroquine et prevalence du paludisme, *Medecine d'Afrique noire*, 24: 117-125 (1977).
46. Dietz, K., Molineaux, L. & Thomas, A. A malaria model tested in African savanna. *Bulletin of the World Health Organization*, 50: 347-357 (1974).
47. Dodge, J. S. Outdoor malaria transmission in a DDT-sprayed area of Western Sokoto, northern Nigeria, Unpublished document WHOMAL/52065 (1965).
48. Dowling, M. A. C. Improvements in techniques for diagnosis of malaria parasites in routine blood examination. Unpublished document WHOME/SGPM/WP/68.15 (1968).
49. Dowling, M. A. C. & Shute, G. T. A comparative study of thick and thin blood films in the diagnosis of scanty malaria parasitaemia. *Bulletin of the World Health Organization*, 34: 249-267 (1966).
50. Draper, K. C. & Draper, C. C. Observations on the growth of African infants, with special reference to the effects of malaria control. *Journal of tropical medicine and hygiene*, 63: 165-171 (1960).
51. Dutertre, J. Etude d'un modéle épidémiologique appliqué au paludisme. *Annales de la Société belge de Médecine tropicale*, 56: 127-141 (1976).
52. Edozien, J. C., Boyd, A. E. & Morley, D. C. The relationship of serum gamma globulin concentration to malaria and sickling. *Journal of clinical pathology*, 13: 118-123 (1960).
53. Escudié, A., Hamon, J., Ricosse, J. -H. & Chartol, A. Résultats de deux ans de chimioprophylaxie antipaludique en milieu rural africain dans la zone pilote de Bobo Dioulasso (Haute Volta). *Medecine tropicale*, 21: 689-728 (1961).

THE GARKI PROJECT

54. Escudié, A., Hamon, J. & Schneider, J. Résultats d'une chimioprophylaxie anti-paludique de masse par l'association amino-4-quinoleine/amino-8-quinoleine en milieu rural africain de la région de Bobo-Dioulasso (Haute Volta). *Medicine tropicale*, 22: 268-305 (1962).
55. Espenshade, E. B. Jr. *Goode's world atlas*. 12th ed. Chicago, Rand McNally, 1964.
56. Field, J. W. & Shute, P. G. The microscopic diagnosis of human malaria. II. A morphological study of the erythrocytic parasites. *Studies from the Institute for Medical Research, Federation of Malaya*, No. 24, p. 25-1 (1956).
57. Field, J. W., Sandosham, A. A. & Fong, Y. L. The microscopical diagnosis of human malaria. I. A morphological study of the erythrocytic parasites in thick blood films (Second edition). *Studies from the Institute for Medical Research, Federation of Malaya*, No. 30, p. 236 (1963).
58. Fine, P. E. M. Superinfection-A problem in formulating a problem (an historical critique of McDonald's theory). *Tropical diseases bulletin*, 72: 475-488 (1975).
59. Fine, P. E. M. Ross's prioripathometry-a perspective. *Proceedings of the Royal Society of Medicine*, 68: 547-551 (1975).
60. Firschein, I. L. Population dynamics of the sickle-cell trait in the Black Caribs of British Honduras, Central America. *American journal of human genetics*, 13: 233-254 (1961).
61. Fleming, A. F., Allan, N. C. & Stenhouse, N. S. Splenomegaly and sickle cell trait. *Lancet*, 2: 574-575 (1968).
62. Fleming, A. F., Storey, J., Molineaux, L., Iroko, E. A. & Attai, E. D. E. Abnormal haemoglobins in the Sudan savanna of Nigeria. I. Prevalence of haemoglobins and relationships between sickle cell trait, malaria and survival. *Annals of tropical medicine and parasitology*, 73: 161-172 (1979).
63. Foll, C. V., Pant, C. P. & Lietaert, P. E. A large-scale field trial with dichlorvos as a residual fumigant insecticide in northern Nigeria. *Bulletin of the World Health Organization*, 32: 531-550 (1965).
64. Fontaine, R. E., Pull, J., Payne, D., Pradhan, G. D., Joshi, G., Pearson, J. A., Thymakis, M. K. & Ramos Camacho, M. E. Evaluation of fenitrothion for the control of malaria. *Bulletin of the World Health Organization*, 56: 445-452 (1978).
- 64a. Friedman, M. J. Erythrocyte mechanism of sickle-cell resistance to malaria. *Proceedings of the National Academy of Science*, 75: 1994-1997 (1978).
65. Garnham, P. C. C. *Malaria parasites, and other haemosporidia*. Oxford, Blackwell, 1966.
66. Garrett-Jones, C. The human blood index of malaria vectors in relation to epidemiological assessment. *Bulletin of the World Health Organization*, 30: 241-261 (1964).
67. Garrett-Jones, C. & Grab, B. The assessment of insecticidal impact on the malaria mosquito's vectorial capacity, from data on the proportion of parous females. *Bulletin of the World Health Organization*, 31: 71-86 (1964).
68. Gillies, M. T. The duration of the gonotrophic cycle in *Anopheles gambiae* and *Anopheles funestus*, with a note on the efficiency of hand catching. *East African medical journal*, 30: 129-135 (1953).
69. Gillies, M. T. A modified technique for the age-grading of populations of *Anopheles gambiae*. *Annals of tropical medicine and parasitology* 52: 261-273 (1958).
70. Gillies, M. T. & de Meillon, B. *The anophelinae of Africa south of the Sahara (Ethiopian Zoogeographical Region)*. South African Institute for Medical Research, Publication No. 54, 2nd ed., 1968, p. 343.
71. Gillies, M. T. & Wilkes, T. J. A study of the age-composition of populations of *Anopheles gambiae* Giles and *A. funestus* Giles in north-eastern Tanzania. *Bulletin of entomological research*, 56: 237-262 (1965).

72. Gordon, R. M. & Davey, T. H. *P. malariae* in Freetown, Sierra Leone. *Annals of tropical medicine and parasitology*, 26: 65-84 (1932).
73. Gordon, R. M. & Davey, T. H. A further note on the increase of *P. malariae* in Freetown, Sierra Leone, *Annals of tropical medicine and parasitology*, 27: 53-55 (1933).
74. Gramiccia, G. & Hempel, J. Mortality and morbidity from malaria in countries where malaria eradication is not making satisfactory progress. *Journal of tropical medicine and hygiene*, 75: 187-192 (1972)
75. Greenwood, B. M. Possible role of B-cell mitogen in hypergammaglobulinaemia in malaria and trypanosomiasis. *Lancet*, 1: 435-436 (1974).
76. Hamilton, P. J. S., Morrow, R. H., Ziegler, J. L., Pike, M. C., Wood, J. B., Banyikidde, S. K. & Hutt, M. S. R. Absence of sickle-cell trait in patients with tropical splenomegaly syndrome. *Lancet*, 2: 109 (1969).
77. Hamon, J. Etude de l'âge physiologique des femelles d'anopheles dans les zones traitées au DDT, et non traitées, de la région de Bobo-Dioulasso, Haute-Volta. *Bulletin of the World Health Organization*, 28: 83-109 (1963).
78. Hamon, J. Malaria: Tropical Africa. In: Cockburn, A., ed., *Infectious diseases: their evaluation and eradication*. Springfield, Thomas, 1967, pp. 276-291.
79. Hamon, J., Choumara, R., Adam, D. & Bailly, H. Le paludisme dans la zone pilote antipaludique de Bobo-Dioulasso (Haute-Volta, A.O.F.) 2ème partie: Enquêtes entomologiques; 3ème partie: Résultats des enquêtes entomologiques. *Cahiers de l'ORSTOM*, No. 1, 37-61, 63-72 (1959).
80. Hamon, J., Mouchet, J., Chauvet, G. & Lumaret, R. Bilan de quatorze années de lutte contre le paludisme dans les pays francophones d'Afrique tropicale et à Madagascar. Considerations sur la persistance de la transmission et perspectives d'avenir. *Bulletin de la Société de pathologie exotique*, 56: 933-971 (1963).
81. Harrison Church, R. J. West Africa: a study of the environment and of man's use of it. In: Beaver, S. H. ed. *Geographies for advanced study*. 6th ed. London, Longmans, 1968.
82. Holstein, M. H. *Biology of Anopheles gambiae: research in French West Africa*. Geneva, World Health Organization Monograph Series No. 9, 1954, p. 172.
83. Huehns, E. R. & Beaven, G. H. Developmental changes in human haemoglobins. In: Benson, P. ed. *The biochemistry of development*. London, Heinemann, 1971, p. 175.
84. Iloeje, N. P. *A new geography of West Africa*. London, Longmans, 1972.
85. James, S. P., Nicol, W. D. & Shute, P. G. A study of induced malignant tertian malaria. *Proceedings of the Royal Society of Medicine*, 25: 1153-1186 (1932).
86. Jelliffe, D. B. *The assessment of the nutritional status of the community (with special reference to field surveys in developing regions of the world)*. Geneva, World Health Organization Monograph Series No. 53 (1966).
87. Kouznetsov, R. L. Malaria control by application of indoor spraying of residual insecticides in tropical Africa and its impact on community health. *Tropical doctor*, 7: 81-91 (1977).
88. Kowal, J. M. & Knabe, D. T. *An agroclimatological atlas of the northern states of Nigeria*. Zaria, Ahmadu Bello University Press, 1972.
89. Kuhlow, F. Field experiments on the behaviour of malaria vectors in an unsprayed hut and in a hut sprayed with DDT in northern Nigeria. Unpublished document WHO/MAL/310 (1961).
90. Lacan, A. Le *Plasmodium ovale* dans les territoires africains d'expression française. *Bulletin of the World Health Organization*, 29: 415-417 (1963).
91. Lehmann, H. & Huntsman, R. G. Laboratory detection of haemoglobinopathies. *Association of Clinical Pathologists broadsheet*, 33: 10 (1975).

92. Livingstone, F. B. Chicago, **Aldine**, 1967, p. 343.
93. Livingstone, F. B. Malaria and human polymorphisms. *Annual review of genetics*, 5: 33-64 (1971).
94. Luzzato, L., Nwachuku-Jarret, E. S., & Reddy, S. Increased sickling of parasitised erythrocytes as mechanism of resistance against malaria in the sickle-cell trait. *Lancet*, 1: 319-321 (1970).
95. Macdonald, G. Malaria in the children of Freetown, Sierra Leone. *Annals of tropical medicine and parasitology* 20 : 239-263 (1926).
96. Macdonald, G. The analysis of infection rates in diseases in which superinfections occur. *Tropical diseases bulletin*, 47: 907-915 (1950).
97. Macdonald, G. The analysis of equilibrium in malaria. *Tropical diseases bulletin*, 49: 813-829 (1952).
98. Macdonald, G. The measurement of malaria transmission. *Proceedings of the Royal Society of Medicine*, 48: 295-301 (1955).
99. Macdonald, G. *The epidemiology and control of malaria*. London, Oxford University Press, 1957, p. 201.
100. Macdonald, G., Foll, C. V. & Cuellar, C. B. The potential value of mass treatment in malaria eradication. Unpublished document WHO/MAL/67.615 (1967).
101. Mancini, G., Carbonara, A. O. & Heremans, J. F. Immunochemical quantitation of antigens by single radial diffusion. *Immunochemistry*, 2: 235-254 (1965).
102. Mathews, H. M., Fried, J. A. & Kagan, I. G. The indirect haemagglutination test for malaria evaluation of antigens prepared from *Plasmodium falciparum* and *Plasmodium vivax*. *American journal of tropical medicine and hygiene*, 24: 417-422 (1975).
103. Matsushima, T., Shidrawi, G. R., Clarke, J. L., Lietaert, P., Ramos-Camacho, E., Boulzaguet, J. R. & Ashkar, T. S. A village scale field trial with propoxur (OMS-33) against *A. gambiae* and *A. funestus*. Unpublished WHO Technical Note No. 7, MPD/TN 73.1, pp. 5-17 (1973).
104. Matsushima, T., Ramos-Camacho, E., & Nambiar, R. V. Report on first year's spraying operation of propoxur. Unpublished WHO Technical Note No. 13, MPD/TN/73.1, pp. 57-64 (1973).
105. Matsushima, T., Brøgger, S., Storey, J., Ramos-Camacho, E., Nambiar, R. V. & Petrides, J. Mass drug administration using a combination of sulfalene and pyrimethamine applied to a rural population in part of Garki District, Kano State, northern Nigeria. (Report on the mass drug administration carried out for the first year of operations (1972)). Unpublished WHO Technical Note No. 18, MPD/TN/74.1, pp. 19-26 (1974).
106. Matsushima, T., Brøgger, S., Nair, V. R. & Nambiar, R. V. Mass drug administration using a combination of sulfamethoxypyrazine and pyrimethamine applied to a rural population in part of Garki district, Kano State, northern Nigeria (Second Report to Technical Note No. 18). Unpublished WHO Technical Note No. 28, MPD/TN/75.1, pp. 53-63 (1975).
107. McGregor, I. A. Measles and child mortality in the Gambia. *West African medical journal*, 13: 251-257 (1964).
108. McGregor, I. A. & Wilson, R. J. M. Precipitating antibodies and immunoglobulins in *P. falciparum* infections in the Gambia, West Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 65 : 136-145 (1971).
109. McGregor I. A., Williams, K., Voller, A. & Billewicz, W. Z. Immunofluorescence and the measurement of immune response to hyperendemic malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 59: 395-414 (1965).

110. McGregor, I. A., Hall, P. J., Williams, K., Hardy, C. L. S. & Turner, M. N. Demonstration of circulating antibodies to by gel diffusion techniques. *Nature*, **210**: 1384 (1966).
111. McGregor, I. A., Turner, M. W., Williams, K. & Hall, P. Soluble antigens in the blood of African patients with severe *Plasmodium falciparum* malaria. *Lancet*, **1**: 881-884 (1968).
112. McGregor, I. A., Rowe, D. S., Wilson, M. E. & Billewicz, W. Z. Plasma immunoglobulin concentrations in an African (Gambian) community in relation to season, malaria and other infections and pregnancy. *Clinical and experimental immunology*, **7**: 51-74 (1970).
113. Meuwissen, J. H. E. T. The indirect haemagglutination test for malaria and its application to epidemiological surveillance. *Bulletin of the World Health Organization*, **50**: 277-286 (1974).
114. Molineaux, L. Entomological parameters in the epidemiology and control of vector-borne diseases. In: *Medical Entomology Centenary, Symposium proceedings*. Royal Society of Tropical Medicine and Hygiene, London, 1978, pp. 100-105.
115. Molineaux, L., Shidrawi, G. R., Clarke, J. L., Boulzaguet, R., Ashkar, T. & Dietz, K. The impact of propoxur on *Anopheles gambiae* s.l. and some other anopheline populations, and its relationship with some pre-spraying variables. *Bulletin of the World Health Organization*, **54**: 379-389 (1976).
116. Molineaux, L., Storey, J., Cohen, J. & Thomas, A. Longitudinal study of *P. falciparum*, *P. malariae* and *P. ovale*, in the West African savanna, in the absence of control measures: II. Relationships between the species of plasmodium, in particular *P. falciparum* and *P. malariae*. Unpublished document MPD-012/78.17 (1977).
117. Molineaux, L., Cornille-Brögger, R., Mathews, H. M. & Storey, J. Longitudinal serological study of malaria in infants in the West African savanna. *Bulletin of the World Health Organization*, **56**: 573-578 (1978).
118. Molineaux, L., Dietz, K. & Thomas, A. Further epidemiological evaluation of a malaria model. *Bulletin of the World Health Organization*, **56**: 565-571 (1978).
119. Molineaux, L., Shidrawi, G. R., Clarke, J. L., Boulzaguet, J. R. & Ashkar, T. S. (1978c). The assessment of insecticidal impact on the malaria mosquito's vectorial capacity, from data on the man-biting rate and age-composition. *Bulletin of the World Health Organization*, **57**: 265-274 (1979).
120. Molineaux, L., Fleming, A. F., Cornille-Brögger, R., Kagan, I. G. & Storey, J. Abnormal haemoglobins in the Sudan savanna of Nigeria. III. Malaria immunoglobulins and antimalarial antibodies in sickle cell disease. *Annals of tropical medicine and parasitology*, **73** : 301-310 (1979).
121. Moškovskij, S. D. A further contribution to the theory of malaria eradication. *Bulletin of the World Health Organization*, **36**: 992-996 (1967).
122. Mouchet, J. & Hamon, J. Les problèmes techniques de l'iradication du paludisme en Afrique. *Cahiers de l'ORSTOM, Entomologie medicata* **1**: 39-48 (1963).
123. Muirhead Thomson, R. C. The effects of house spraying with pyrethrum and with DDT on *Anopheles gambiae* and *A. melas* in West Africa. *Bulletin of entomological research*, **38**: 449-464 (1974).
124. Muirhead Thomson, R. C. Recent knowledge about malariavectors in West Africa and their control. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **40**: 511-536 (1974).
125. Najera, J. A. A critical review of the field application of a mathematical model of malaria eradication. *Bulletin of the World Health Organization*, **50**: 449-457 (1974).
126. Najera, J. A., Shidrawi, G. R., Storey, J. & Lietaert, P. E. A. Mass drug administration and DDT indoor-spraying as antimalarial measures in the northern savanna of Nigeria. Unpublished document WHO/MAL/73.817 (1973).

127. Nambiar, R. V., Ramos-Camacho, E., & Matsushima, T. Report on second year's (1973) spraying operation of propoxur. Unpublished WHO Technical Note No. 26, **MPD/TN/75.1**, pp. 39-42 (1975).
128. Newman, P. *Malaria eradication and population growth, with special reference to Ceylon and British Guiana*. Bureau of Public Health Economics, University of Michigan, Ann Arbor, Research Series No. 10, 1965.
129. Olaofe, G. O. & Olaofe, K. A simple model for tropical malaria epidemics. *Mathematical biosciences*, 25: 205-215 (1975).
130. Omer, S. M. & Cloudsley-Thompson, J. L. Survival of female *Anopheles gambiae* Giles through a nine-month dry season in Sudan. *Bulletin of the World Health Organization*, 42: 319-330 (1970).
131. Onori, E. Distribution of *Plasmodium ovale* in the eastern, western and northern Regions of Uganda. *Bulletin of the World Health Organization*, 37: 665-668 (1967).
- 131a. Pasvol, G., Weatherall, D. J. & Wilson, R. J. M. Cellular mechanism for the protective effect of haemoglobin S against *P. falciparum* malaria, *Nature*, 274: 701-703 (1978).
132. Payne, D., Grab, B., Fontaine, R. E. & Hempel, J. H. G. Impact of control measures on malaria transmission and general mortality. *Bulletin of the World Health Organization*, 54: 369-377 (1976).
133. Peaston, N. & Renner, E. A. Report on an examination of the spleen and parasite rates in school-children in Freetown, Sierra Leone. *Annals of tropical medicine and parasitology*, 33: 49-61 (1939).
134. Pringle, G. Experimental malaria control and demography in a rural East African community: a retrospect. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 63, No. 4, suppl., pp. S2-S18 (1969).
135. Radcliffe, J. The periodicity of endemic malaria. *Journal of applied probability*, 11: 562-567 (1974).
136. Rao, N. R., Vig, O. P. & Agarwala, S. N. Transmission dynamics of malaria. *Bulletin of the Haffkine Institute*, 2: 71-78, 112-116 (1974).
137. Raper, A. B. Sickling and malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 54: 503-504 (1960).
138. Ringelmann, B., Hathorn, M. K. S., Jully, P., Grant, F. & Parniczky, G. A new look at the protection of haemoglobin AS and AC genotypes against *Plasmodium falciparum* infection: a census tract approach. *American journal of human genetics*, 28: 270-279 (1976).
139. Rogers, N. A., Fried, J. A. & Kagan, I. G. A modified indirect microhaemagglutination test for malaria. *American journal of tropical medicine and hygiene*, 17: 804-809 (1968).
140. Rowe, D. S., McGregor, I. A., Smith, S. J., Hall, P. & Williams, K. Plasma immunoglobulin concentrations in a West African (Gambian) community and in a group of healthy British adults. *Clinical and experimental immunology*, 3: 63-79 (1968).
141. Rowe, D. S., Grab, B. & Anderson, S. An international reference preparation for human serum immunoglobulins G, A and M: content of immunoglobulin by weight. *Bulletin of the World Health Organization*, 46: 67-69 (1972).
142. Rucknagel, D. L. & Neel, J. V. The haemoglobinopathies. In: Steinberg, G. ed. *Progress in medical genetics*. New York, Grune & Stratton, 1961, p. 158.
143. Scrimshaw, N. S., Taylor, C. E. & Gordon, J. E. *Interactions of nutrition and infection*. Geneva, World Health Organization Monograph Series No. 57, 1968.
144. Service, M. W. Some basic entomological factors concerned with the transmission and control of malaria in northern Nigeria. *Transactions of the Royal Society for Tropical Medicine and Hygiene*, 59: 291-296 (1965).

REFERENCES

145. Shidrawi, G. R. The distribution and seasonal prevalence of members of the *Anopheles gambiae* species complex (species A and B) in Garki District, northern Nigeria. Unpublished document **WHO/MAL/72.776—WHO/VBC/72.387** (1972).
146. Shidrawi, G. R., Clarke, J. L. & Boulzaguet, J. R. Assessment of the CDC miniature light trap for sampling malaria vectors in Garki District, northern Nigeria. Unpublished WHO Technical Note No. 11, **MPD/TN/73.1**, pp. 44-49 (1973).
147. Shute, P. G. & Maryon, M. A contribution to the problem of strains of human plasmodium. *Rivista di malariologia*, 33: 1-21 (1954).
148. Storey, J. & Matsushima, T. Observations on patient attendance at dispensaries in Garki district, Kano State, Nigeria. Unpublished WHO Technical Note No. 8, **MPD/TN/73.1**, pp. 18-28 (1973).
149. Storey, J., Brögger, S. & Molineaux, L. A trial of methods for the microscopic detection of malaria in man. Unpublished WHO Technical Note No. 9, **MPD/TN/73.1**, pp. 29-38 (1973).
150. Storey, J., Rossi-Espagnet, A., Mandel, S. P. H., Matsushima, T., Lietaert, P., Thomas, D., Brögger, S., Duby, C. & Gramiccia, G. Sulfalene with pyrimethamine and chloroquine with pyrimethamine in single-dose treatment of *Plasmodium falciparum* infections: a trial in a rural population in northern Nigeria. *Bulletin of the World Health Organization*, 49: 275-282 (1973).
151. Storey, J., Nambiar, R. V. & Matsushima, T. Drug administration to self-reported fever cases through village and hamlet heads in Garki district, Kano State. Unpublished WHO Technical Note No. 27, **MPD/TN/75.1**, pp. 43-52 (1975).
152. Storey, J., Brögger, S. & Molineaux, L. Longitudinal study of *P. falciparum*, *P. malariae* and *P. ovale*, in the west African savanna in the absence of control measures. I. Prevalence, incidence of and recovery from patent parasitaemia. Unpublished document **MPD-012/78.16** (1977).
153. Storey, J., Fleming, A. F., Cornille-Brögger, R., Molineaux, L., Matsushima, T. & Kagan, I. Abnormal haemoglobins in the Sudan savanna of Nigeria. IV. Malaria, immunoglobulins and antimalarial antibodies in haemoglobin AC individuals. *Annals of tropical medicine and parasitology*, 73 : 3 1 1-3 15 (1979).
154. Sulzer, A. J., Cantella, R., Colichan, A., Gleason, N. N. & Walls, K. W. A focus of hyperendemic *Plasmodium malariae*-*P. vivax* malaria with no *P. falciparum* in a primitive population in the Peruvian Amazon jungle. Studies by means of immunofluorescence and blood smear. Unpublished document **WHO/MAL/75.858** (1975).
155. Vandepitte, J. M., Zuelzer, W. W., Neel, J. V. & Colaert, J. Evidence concerning the inadequacy of mutation as an explanation of the frequency of the sickle cell gene in the Belgian Congo. *Blood*, 10: 341-350 (1955).
156. Vaughan, V. C. Growth and development. In: Vaughan, V. C. & McKay, R. J. eds. *Nelson textbook of pediatrics*, 10th ed. Philadelphia, Saunders, 1975.
157. Voller, A. & O'Neill, P. Immunofluorescence method suitable for large-scale application. *Bulletin of the World Health Organization*, 45: 524-529 (1971).
158. Voller, A., Bidwell, D., Huldt, G & Engvall, E. A microplate method of enzyme-linked immunosorbent assay and its application to malaria. *Bulletin of the World Health Organization*, 51: 209-211 (1974).
159. Voller, A., Bidwell, D. E. & Bartlett, A. Enzyme immunoassays in diagnostic medicine; theory and practice. *Bulletin of the World Health Organization*, 53: 55-65 (1976).
160. Walters, J. H. & Bruce-Chwatt, L. J. Sickle-cell anaemia and falciparum malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 50: 5 1 1-5 14 (1956).
161. Walton, G. A. *Plasmodium falciparum* and *Anopheles gambiae* in relation to malaria occurring in infants: on the control of malaria in Freetown, Sierra Leone. *Annals of tropical medicine and parasitology*, 41: 380-407 (1947).

162. Watson, E. H. & Lowrey, G. H. *Growth and development of children*. 5th ed. Chicago, Year Book Medical Publishers, 1967.
163. White, G. B. *Anophelesgambiaecomplex* and disease transmission in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **68**: 278-298 (1974).
164. Wilson, B. (1949) Malaria incidence in Central and South Africa. In: Boyd, M. D. ed. *Malariaology*, Philadelphia, Saunders, 1949, pp. 800-809.
165. Wood, C. S. The relationship between ABO polymorphisms and malaria vectors. *Human biology*, **46**: 385-404 (1974).
166. Wood, C. S., Harrison, G. A., Doré, C. & Weiner, J. S. Selective feeding of *A. gambiae* according to ABO blood group status, *Nature*, **239**: 165 (1972).
167. WHO. *Report on the malaria conference in equatorial Africa*. Geneva, World Health Organization Technical Report Series No. 38, p. 72 (1951).
168. WHO. Manual for processing and examination of blood slides in malaria eradication programmes (2nd edition), Unpublished document WHO/PA/262.61, p. 127 (1961).
169. WHO. Malaria eradication. Report on the Third African Malaria Conference, Yaoundé, 3-13 July 1962. Unpublished document WHO/MAL/376—AFR/MAL/9/62 (1963).
170. WHO. Informal meeting on the priority needs of field research in malaria in tropical Africa. Unpublished document MPD 012/78.18 (1969).
171. WHO. Parasitology baseline report (1971-1972). Unpublished document MPD 012/78.01 (1974).
172. WHO. Parasitology-intervention phase report (1971-1972), Unpublished document MPD 012/78.02 (1974).
173. WHO. Immunology baseline report (1971-1972). Unpublished document MPD 012/78.03 (1974).
174. WHO. Immunology-intervention phase report (1972-1973). Unpublished document MPD 012/78.04 (1974).
175. WHO. Entomology baseline report (1971-1972). Unpublished document MPD 012/78.05 (1974).
176. WHO. *Manual on practical entomology in Malaria*. Geneva, WHO offset publication, No. 13, 1975, Part I, 160 pp. Part II, 191 pp.
177. WHO. Entomology intervention phase report (1971-1973). Unpublished document MPD 012/78.06 (1975).
178. WHO. Meteorology, baseline and intervention period, including relationship of entomological findings (1971-1973). Unpublished document MPD 012/78.07 (1975).
179. WHO. The intervention period: the control operations (1972-1973). Unpublished document MPD 012/78.08 (1975).
180. WHO. Demographic report (1971-1973). Unpublished document MPD 012/78.09 (1975).
181. WHO. Informal consultation on project MPD 012: research in the epidemiology and control of malaria in African savanna. Unpublished document MPD 012/78.11 (1975).
182. WHO Scientific Group on Developments in Malaria Immunology. *Report*. Geneva, World Health Organization Technical Report Series No. 579 (1975).
183. WHO. The epidemiological benefits expected from a *P. falciparum* vaccine: a simulation exercise. Unpublished document MPD 012/78.12 (1976).
184. WHO. Garki Project: Entomology 1974-1975. Unpublished document MPD 012/78.13 (1976).
185. WHO. Garki Project: Parasitology 1974-1975. Unpublished document MPD 012/78.14 (1976).

ACKNOWLEDGEMENTS

The work carried out in the Garki project would not have been possible without the support and dedication of the national authorities and of all the project staff at Federal, State, District and village levels. The understanding and the co-operation of the population, often put to inconvenience in their own homes, made it possible to satisfy the requirements of the research work.

It would be impossible to mention them all individually, but we would like to single out the following:

Federal Government of Nigeria

Emirate and Local Government Authority

His Highness Alhaji Audu Bayero, Emir of Kano
Alhaji Umaru Sarkin Fulani J.aidinawa, District Head, Garki

State Government, Ministry of Health

Alhaji Mohammed Ibrahim, Permanent Secretary
Dr I. Imam, Director Medical Services
Dr Qureshi, Principal Medical Officer, Preventive
Dr Baisu, Principal Medical Officer, Curative

The University of Ibadan and especially the Staff of the Department of Clinical Pathology (Host to the WHO-Immunology Research and Training Centre, Dr V. Houba) under the leadership of Prof. B. K. Adadevoh, gave tremendous assistance in the early setting-up of the serological part of the project.

The continuous help provided by the WHO representatives in Nigeria at Lagos (Dr D. A. W. Nugent, Dr S. Adrienand finally Dr E. S. W. Bidwell) and by their staff, in clearing and forwarding the imported goods for the project and in discussing administrative questions with representatives of the Federal Government, is acknowledged with gratitude.

The preparation of the anti-immunoglobulins antisera for the project fell on Miss K. Hug of the Institut de Biochimie of the University of Lausanne, Switzerland, directed by Professor H. Isliker. The Institute were the host to the WHO Immunology Research and Training Centre, headed by Dr D. S. Rowe, who supervised Miss Hug's work. Their very important contribution to the serological aspects of the research is acknowledged.

Finally, special thanks should be given to Mrs M. Escribano-Matty for revising and preparing all the figures and tables and the references, and to Miss Frances Bonello for typing the text of this publication.