What is a cause?

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- The same organism must be present in every case of the disease.

- The organism must be isolated from the diseased host and grown in pure culture.

- The isolate must cause the disease when inoculated into a healthy, susceptible animal.

- The organism must be reisolated from the inoculated, diseased animal.

[Grimes, D.J. 2006. "Koch's Postulates—Then and Now," *Microbe*. **1**(5): 223—8.]

Bradford Hill (1965)

- What in an association should we consider when determining causation?
  - Strength of association
  - Consistency
  - Specificity
  - Temporal sequence
  - Biological gradient (dose-response)
  - Plausibility and coherence
  - Experimental or interventional evidence
  - Analogy

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Cause in philosophy

- 300 years of philosophy on cause

- Lots of different schemes of causation

  – Humean / regularity view of causation

  – Counterfactual conditional causation

  – Cause and linking mechanism

  – Probabilistic / indeterminate cause including Bayesian

  – Action-related causation

Cause in philosophy

- No dominant view either between schemes or within schemes

- Extensive, difficult literature

- Very often written to account for theoretical rather than actual examples

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- This might be a route to improvements...

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- Should incorporate elements from the philosophy of causation

Example of causation in disease discovery

Burkitt's Lymphoma

- B-cell nonfollicular lymphoma

- Highly malignant

- Common in tropical Africa

- Jaw and abdominal tumours

- Caused by the Epstein-Barr virus and related to chronic malaria

- First described 1958 by Denis Burkitt
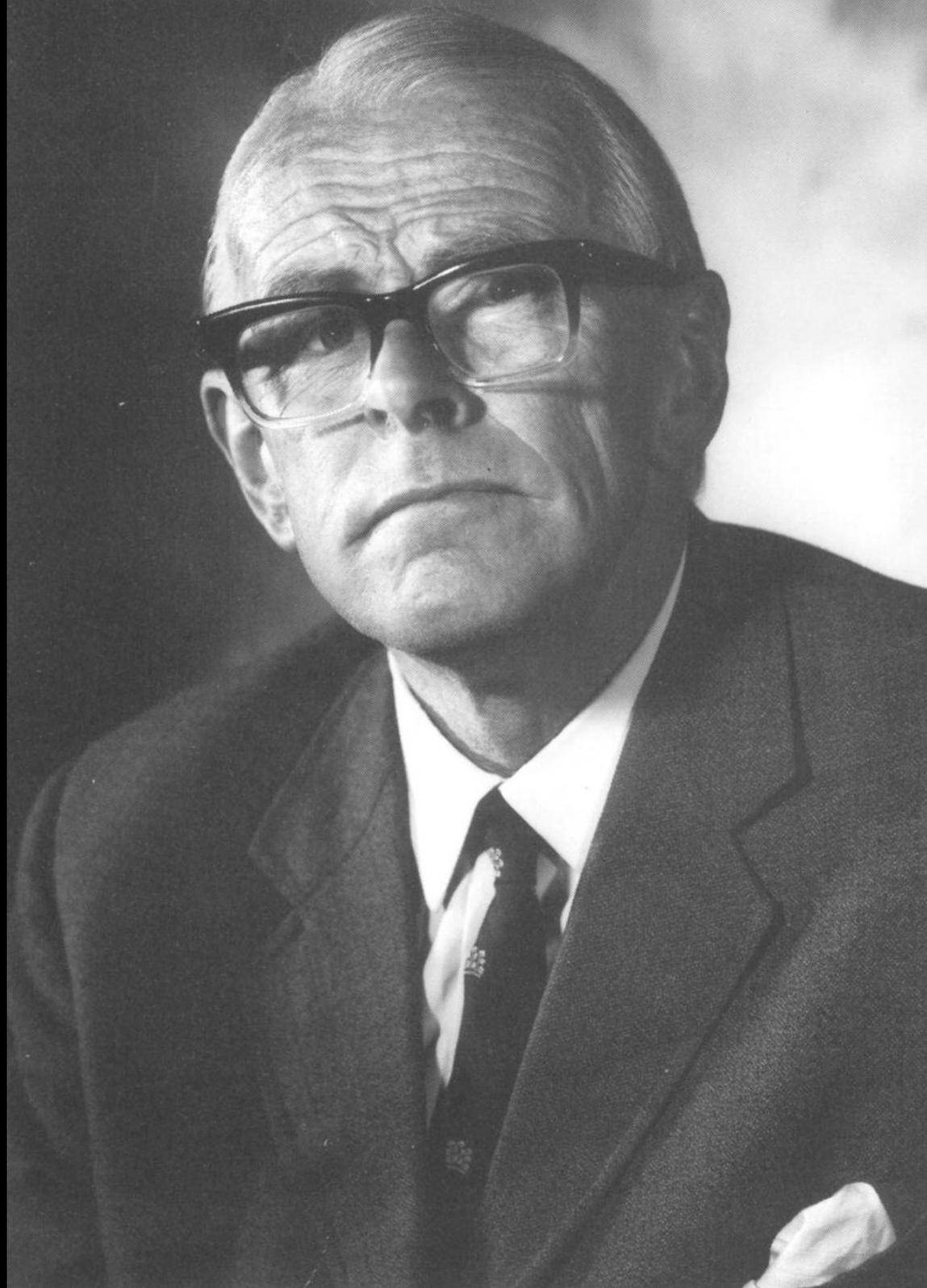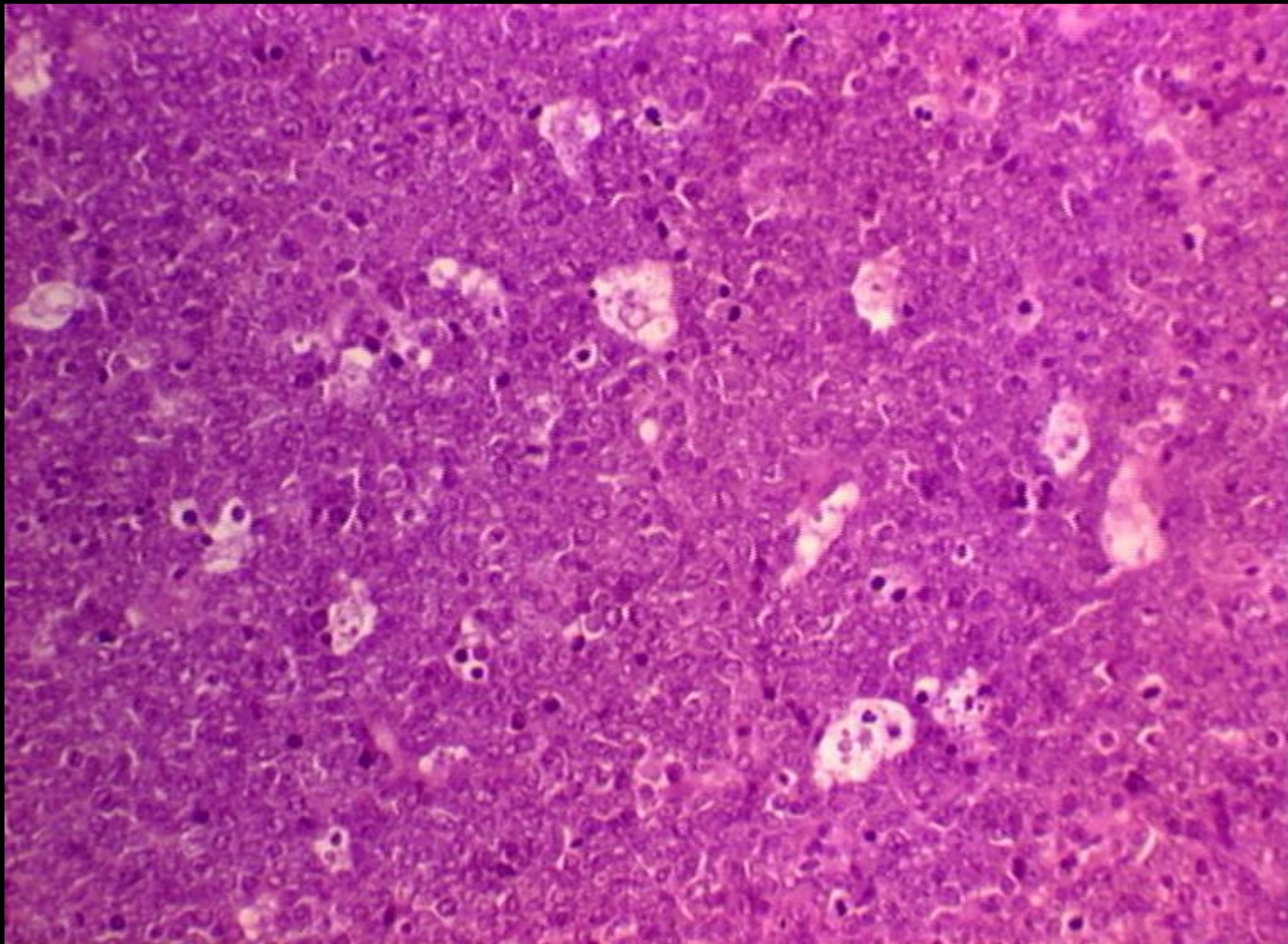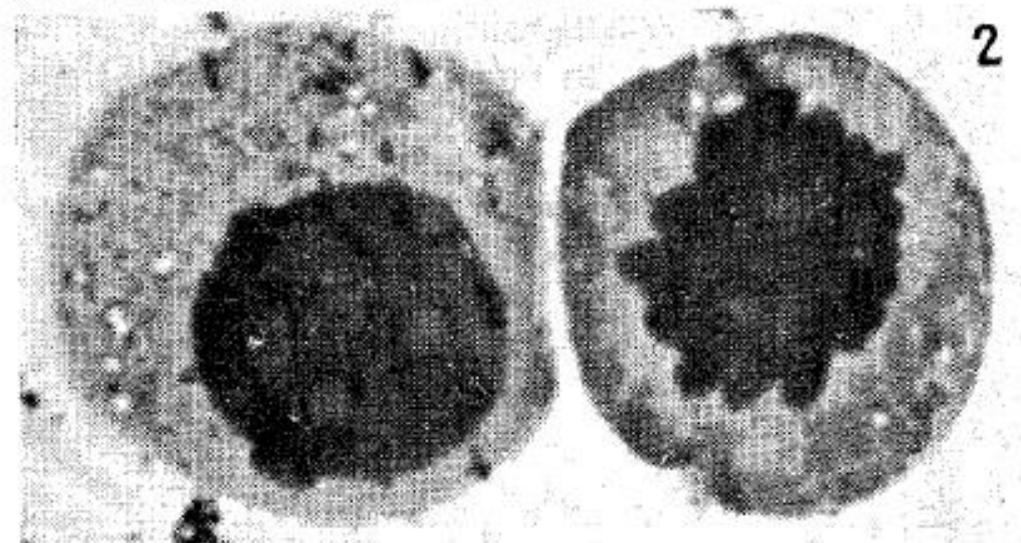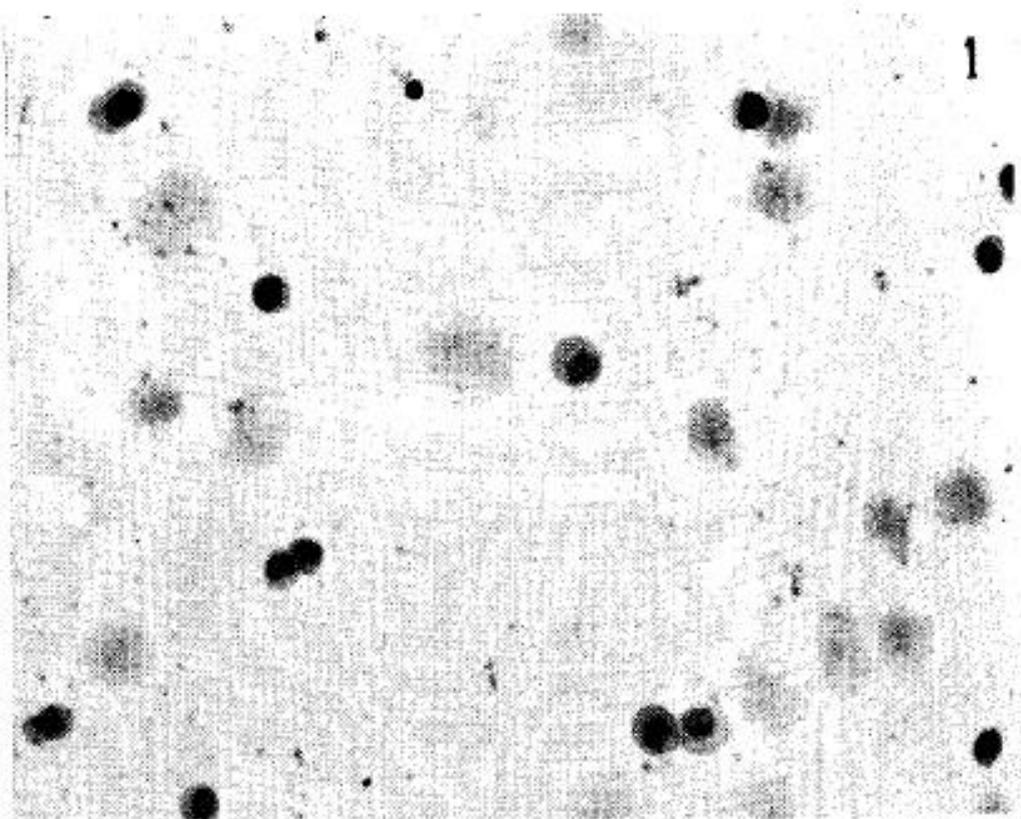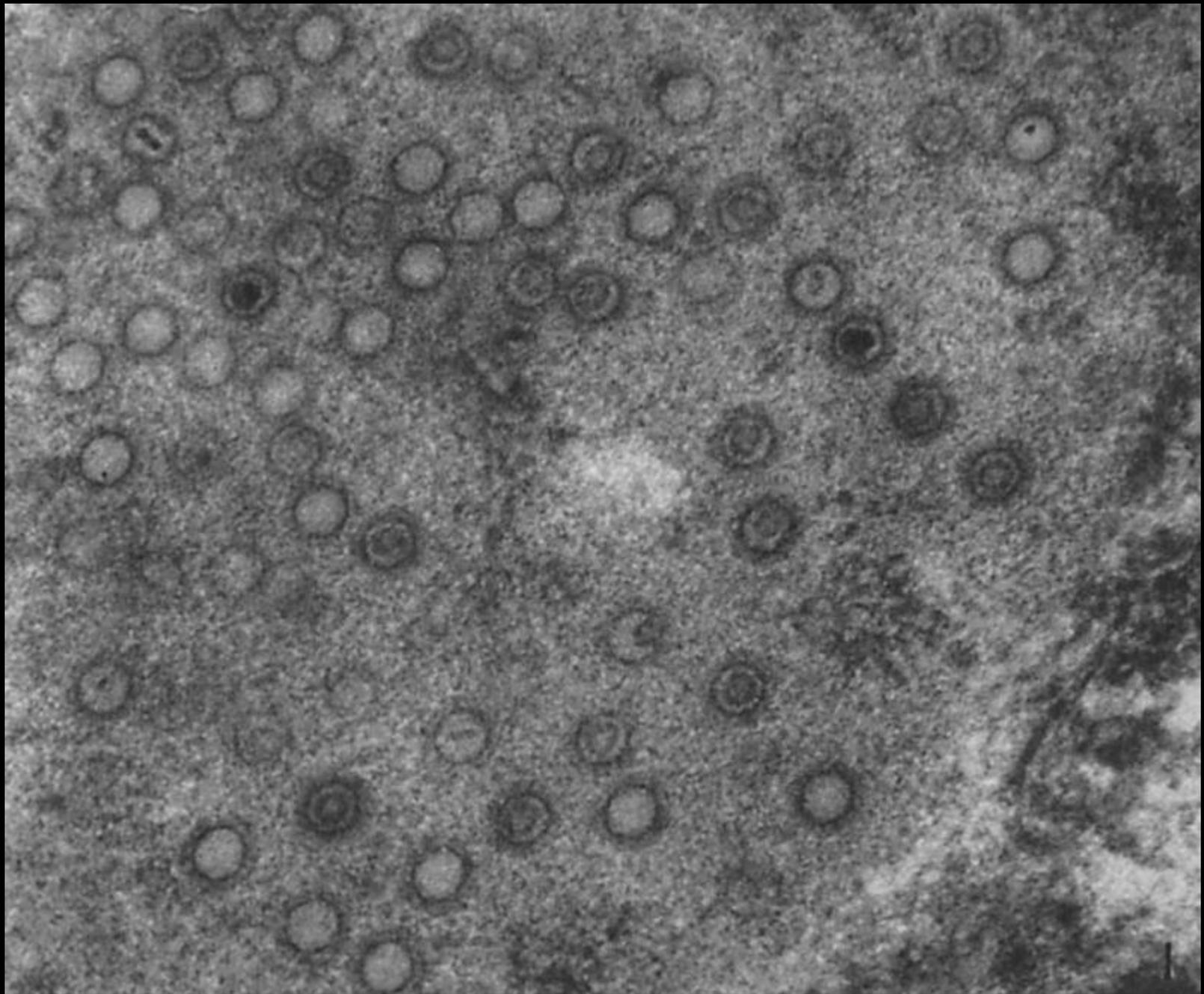
# But Epstein-Barr was not the only virus found in Burkitt's Lymphoma cells...

- Arbovirus

- Echo 11

- HSV

- Reovirus 3

- Multiple other filterable agents
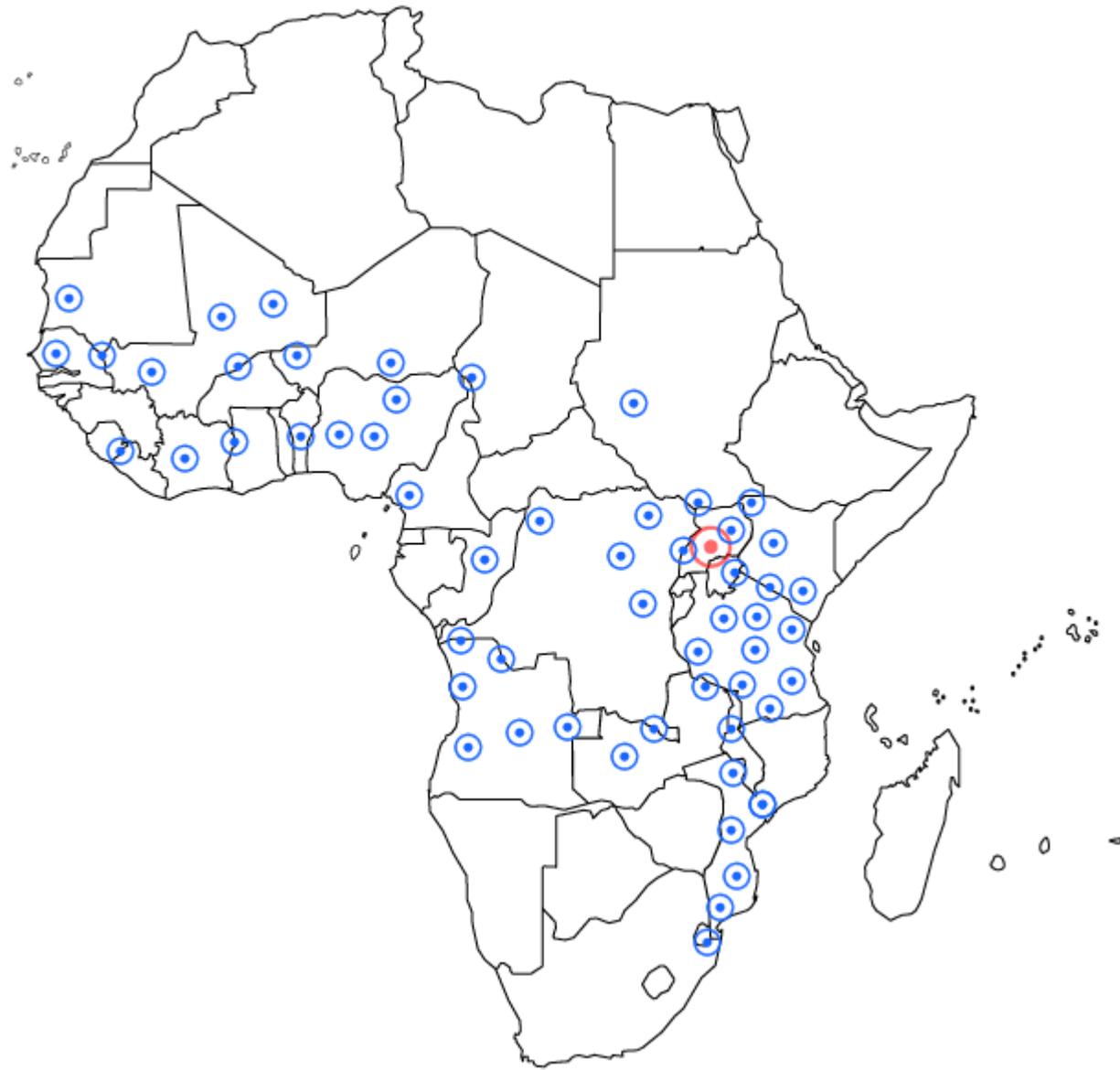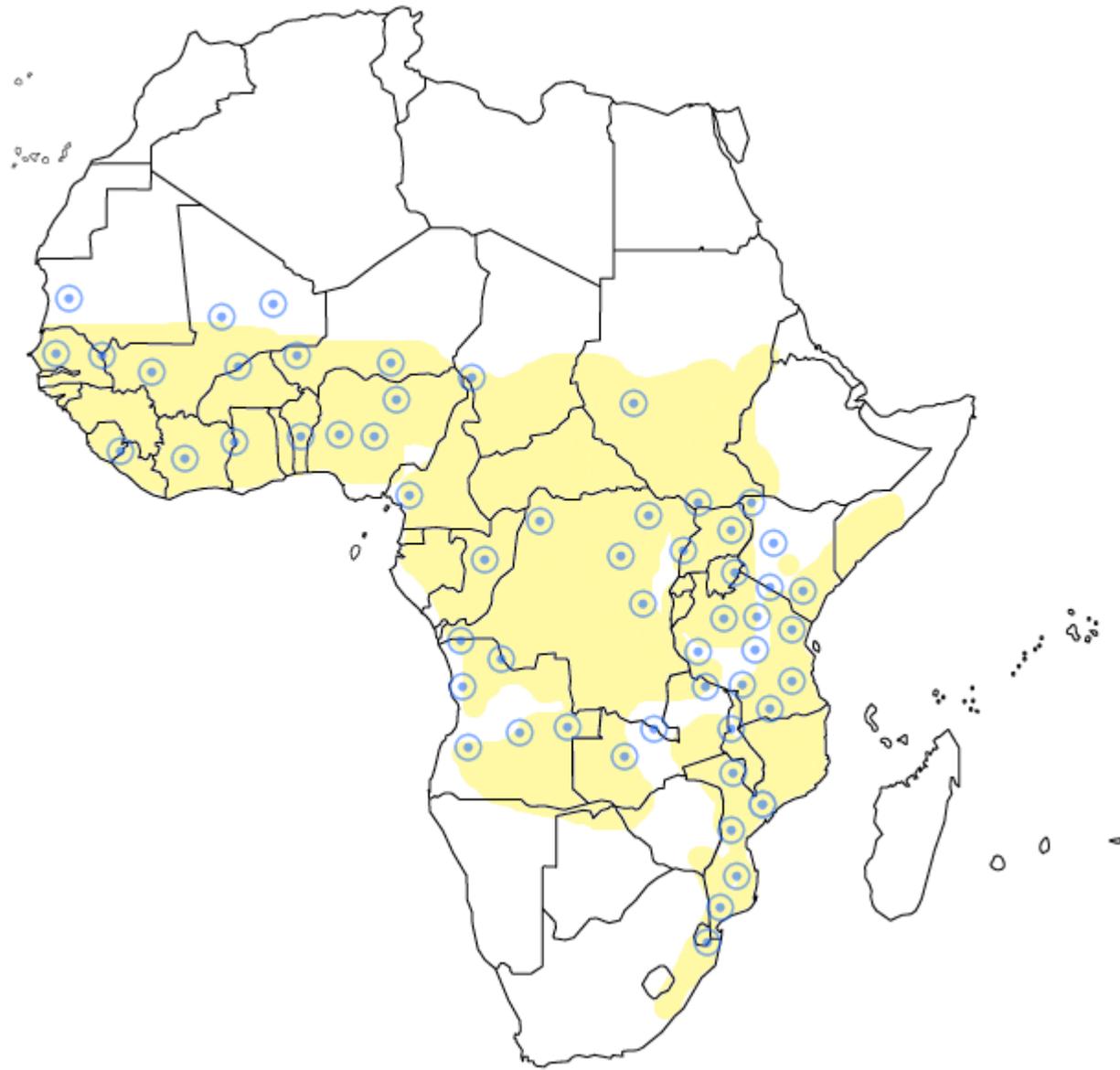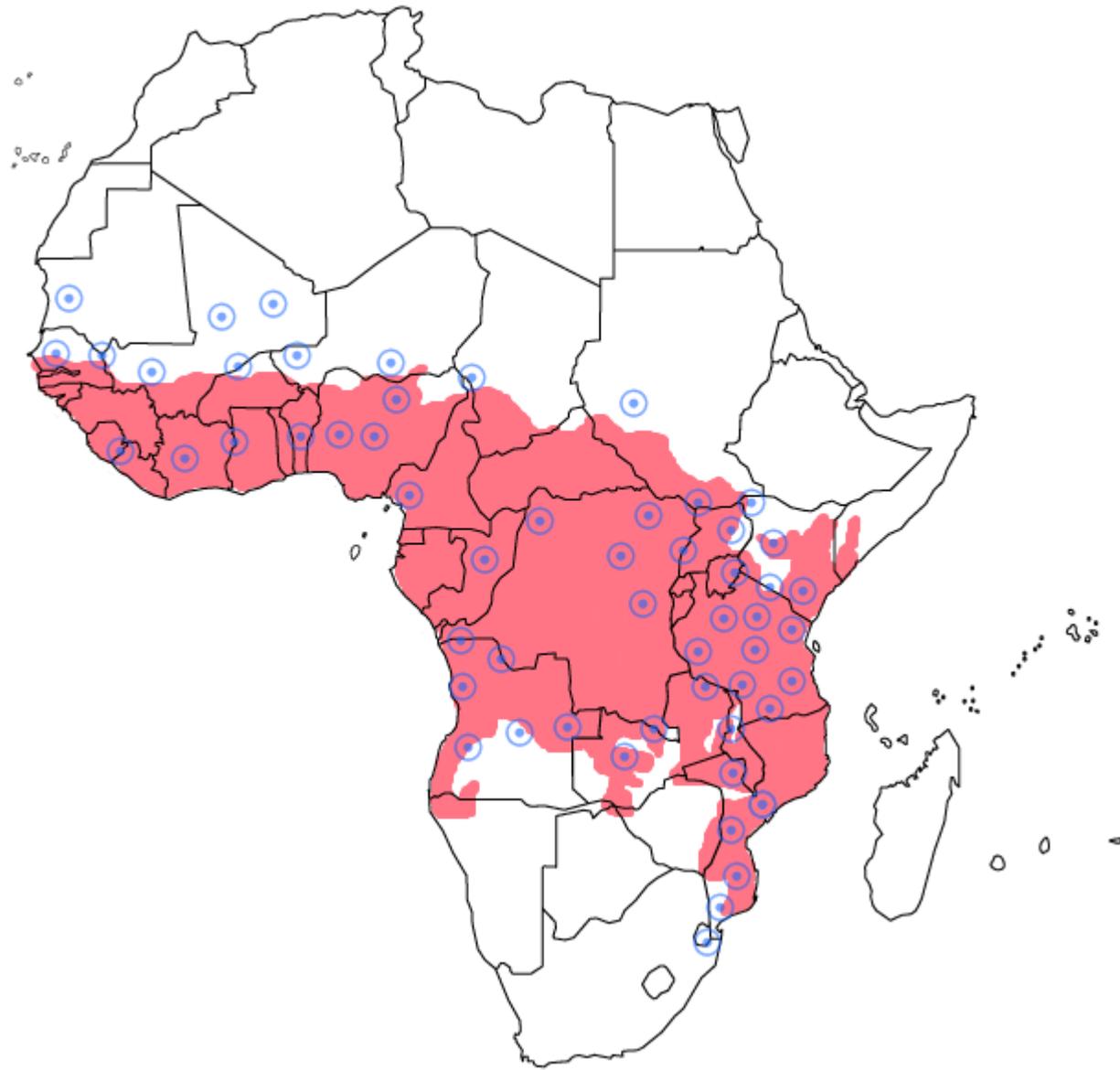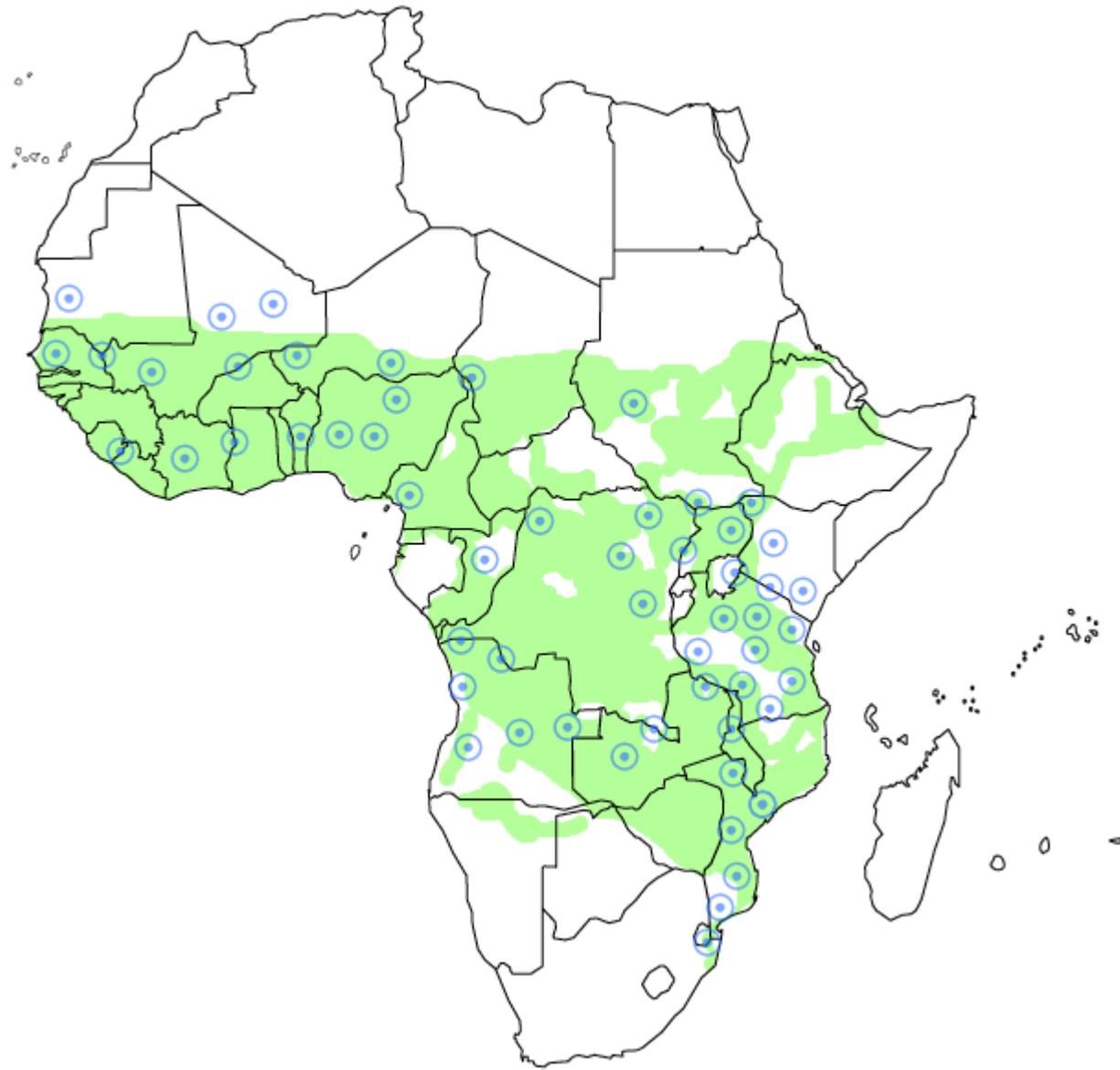
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  – Epidemiological and seroepidemiological evidence, especially prospective studies

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3. There is room for improvement in existing schemes of cause in both medicine and philosophy

4. Cause seems to require evidence from multiple domains

5. New schemes of cause must take account of the needs of biomedicine, the demands of philosophy and the manner in which medicine actually happens