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Precipitin Tests as a Basis for a Quantitative Phylogeny.

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In an earlier report¹ the results of a series of precipitin tests on the sera of certain common Mammalia were given. The degree of reaction as indicated by the titer of the ring tests was expressed as percent of the homologous titers. A new method of using these percent values as a basis for a quantitative phylogeny is here proposed and illustrated.

The method involves the calculation of the average values of the reciprocal relationships between pairs of species. These average values (M) constitute the primary data to be used. The values of M together with their probable errors are given in Table I.

TABLE I.

Average reciprocal values of mammalian sera (M) together with their probable errors, and the values of 100-M for all the species tested reciprocally.

| Species | M (%) | P.E. _M | 100-M |
|-----------------|-------|-------------------|-------|
| Dog vs. Horse | 4.9 | ±1.49 | 95.1 |
| “ “ Sheep | 5.5 | ±1.37 | 94.5 |
| “ “ Pig | 6.2 | ±0.87 | 93.8 |
| “ “ Beef | 10.5 | ±1.5 | 89.5 |
| Beef vs. Horse | 9.4 | ±1.08 | 90.6 |
| “ “ Pig | 13.2 | ±0.78 | 86.8 |
| “ “ Sheep | 69.3 | ±4.7 | 30.7 |
| Sheep vs. Horse | 3.7 | ±0.79 | 96.3 |
| “ “ Pig | 7.7 | ±0.92 | 92.3 |
| Pig vs. Horse | 5.5 | ±0.98 | 94.5 |

The least reliable value (dog vs. horse) is still 3.3 times its P.E., and hence the whole series is probably significant. To express these quantitative measures of relationship graphically, it is proposed to use the corresponding 100-M values for the actual distances between the loci of the species. For example, taking dog as the starting point, the distances of the other species from dog are given in the table. The positions of the other species, beef, sheep, pig and horse may then be further defined by their corresponding 100-M values in relation to each other. There will be four 100-M values to be used in establishing the proper locus of each species and all must be so used. The result is shown in Fig. 1, which gives a side view of the spatial arrangement of the loci projected on a plane surface.

¹ Boyden, A. A., *Biol. Bull.*, 1926, **50**, 73.

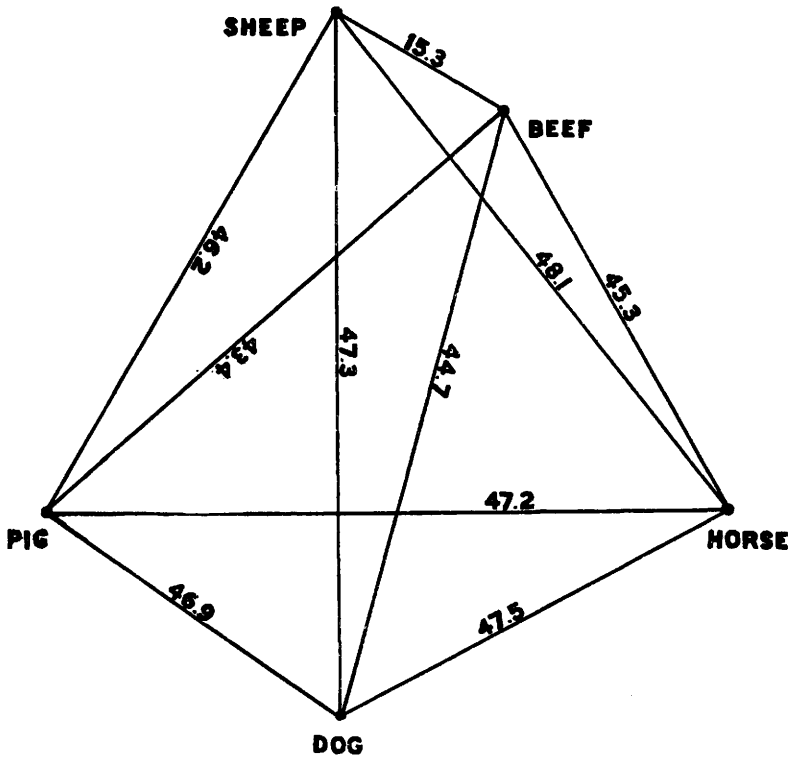


FIG. 1.

The 3-dimensional figure obtained by using the 100-M values of Table I, projected on a plane surface. The unit of distance employed was 0.5 cm., and the numbers shown on each line are the actual centimeter distances of the resulting figure. The figure agrees with the calculated values with an average error per line of 5.8%. None of the lines deviates more than 10.2%.

It should be borne in mind that Fig. 1 shows *only the present relationships* of these 5 species, not their ancestry. The figure does not show time and hence cannot show ancestry. To add the element of time to this geometric figure would require a fourth dimension.

The figure demonstrates 2 significant facts, (1) that the species tested do fall into positions determinable by the primary data, and (2) the present relationships of these species require 3 dimensions for their expression.

Knowledge of phylogeny is of 2 chief kinds: (1) that regarding the present relationships of existing species; (2) that regarding their ancestry. To construct a complete phylogenetic tree requires both kinds of knowledge. Heretofore quantitative measures of present relationships have been almost entirely lacking and information as to ancestry has been even less certain. It may be, how-

ever, that these precipitin tests can give us quantitative measures of the present relationships of existing forms and thus supply exact ideas as to that part of their phylogeny which concerns their present position on the phylogenetic tree. If so the tests will have succeeded in giving us what a century or more of intensive morphological investigation has failed to provide, namely, a basis for a quantitative phylogeny.

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Note on the Correlation between Chronaxie and Reaction Time.

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The researches of Lopicque and Bourguignon have shown that the excitability of muscles as measured by their chronaxie is closely associated with the form and duration of their contraction, the general rule being that the slower the contraction the longer the chronaxie and vice versa. This has been attested, on the one hand, by the comparatively long chronaxies of smooth as compared with striated musculature (animals) and on the other hand, by the chronaxie changes following nerve degeneration and those met with in the various muscular dystrophies.

In view of this association it seemed to us that there might be some correlation between motor speed and neuromuscular excitability, which might account for differences in speed of movement, on the basis of a constitutional (organic) factor. The present note is a report on the results obtained by simultaneous measurement of the chronaxie and reaction time in 20 normal human subjects.

In obtaining the chronaxie we followed Bourguignon's technique, employing a method described by us in a previous paper,¹ with the apparatus assembled into a simple portable form devised by one of us. The chronaxie was taken over the motor point of the biceps muscle. The average of five readings was taken as the chronaxie.

The speed of bicepital contraction against which we correlated the muscle chronaxie was obtained as follows: Each subject after placing his forearm, fist clenched, upon a table in front of him was

¹ Wechsler, D., and Freeman, R. G., Jr., *Arch. Neur. and Psych.*, 1929, **22**, 558.