that these six doublets are the isotope lines P_{56} to P_{61}, due to $C^{13} - N^{14}$. They have the same doublet separation as the main doublets, and lie just to the red, in each case. In calculating the vibrational shift I have used the constants based on Heurlinger's original analysis, as calculated by Kratzer (*Ann. d. Phys.*, **71**, 72; 1923). For the rotational shift I have used new constants determined by R. T. Birge and W. O. Smith, in an unpublished quantum analysis of this band. The calculated shift varies from 0·228 mm. to 0·451 mm. (0·877 cm.$^{-1}$ to 1·739 cm.$^{-1}$).

Although the isotope lines are very faint, they can under favourable mechanical conditions be measured with reasonable accuracy. Excluding P_{56}, which lies too close to its parent line to measure properly, the observed isotope shift averages 0·014 mm. greater than the calculated, with an average deviation from the mean of only 0·0033 mm. This indicates a small error in the vibrational constants, or an electronic shift of this magnitude (0·05 cm.$^{-1}$). The latter explanation seems the more reasonable. The calculated isotope lines based on either $C^{12} - N^{15}$ or $C^{12} - N^{16}$ lie far outside the limits of error. There are definitely no other isotope lines observable in this region of the band, so that one may conclude that if isotopes of nitrogen exist, they are much less abundant, compared to N^{14}, than is C^{13} compared to C^{12}.

RAYMOND T. BIRGE.

University of California, June 29.

Fossil Records of Mendelian Mutants.

WITH the help of Prof. A. E. Boycott and others, I have been engaged for the past ten years in collecting data for the study of the distribution of variations in natural populations. The species selected for study were the two common and very variable British land-snails, *Helix* (*Cepœa*) *nemoralis* L. and *H.* (*Cepœa*) *hortensis*, Müll. These snails normally occur in populous and well-defined colonies. In habit they are sedentary and apparently seldom move far from their birth-place. Most of the variations taken into consideration are those that affect the colour and banding of the shell. The classical experiments of Lang, and the wider, but as yet mainly unpublished, work of Mr. A. W. Stelfox, have shown that several of the colour and band forms are inherited on simple Mendelian lines. Both species are recorded fossil from the Red Crag of Butley (Pliocene) and subsequent strata, and *C. nemoralis* from the Miocene of France (A. E. Ellis, "British Snails", 1926). Mr. J. W. Taylor in his monograph of the land and freshwater Mollusca of the British Isles gives numerous records of the geological distribution, and says of *C. hortensis* that in a pleistocene deposit (Ightham, Kent) the five-banded and unbanded forms were about equally numerous. To-day, bandedness is known to be a simple recessive to unbandedness in both species. Mr. W. J. Wintle (*Proc. Malac. Soc.*, **16**, 171-8; 1925) reports that on Caldey Island, *C. nemoralis* is very common as a living snail and as a pleistocene and holocene fossil. He states that among the living snails the unbanded form seems rather more common than the banded forms but that the reverse is true of the pleistocene shells. In neither of these cases, however, are any figures quoted.

In the living colonies studied by me the various phenotypes, as might be expected, occur with very different frequency; and the frequencies of any one phenotype may show a significant difference in samples separated by only a few yards. But on the whole series of colonies, banded types, taken together, are more prevalent than the unbanded form. Fortunately, the banding of the shell is easily seen in fossil material; detailed data, therefore, of the frequency of the different types in fossil samples could be obtained and would be of considerable interest from the point of view of genetics and natural selection theory. I am very grateful to Mr. A. S. Kennard, who has kindly supplied me with the figures for three fair-sized samples, each containing both species, from deposits near Goodwood. The samples are dated "Early Iron Age" and "Neolithic"; among the *C. nemoralis* there are four types, and among the *C. hortensis* two types, that are known to be inherited in a simple Mendelian manner. In all three samples the banded types taken together are numerically superior to the unbanded shells and the frequencies of the different types are just such as might be found to-day.

I need scarcely say that I should welcome any further data, references to already published data, or fossil material bearing on this point. C. DIVER.

40 Pembroke Square,
Kensington, W.8, July 17.

Mimicry.

PROF. MACBRIDE'S reply to my criticisms of his views on mimicry, which appeared in NATURE of May 11, has just reached me. Before this letter reaches England others may have dealt with this, but I would ask indulgence for a few remarks.

(1) It is to be regretted that opponents of the explanation of mimicry by natural selection so frequently rely upon arguments which overlook recorded facts. Such an argument was noted in section 9 of my article, and now Prof. MacBride quotes Bergh as evidence that butterflies are not eaten by birds. I would refer him to the discussion of this subject in Chapter x. of "A Naturalist on Lake Victoria", and to the following readily accessible publications: *Trans. Ent. Soc. London*, Part 3, pp. 353-71, 1902; *Proc. Ent. Soc., London*, pp. xxxii-xliii, 1915; *Jour. Linn. Soc.*, Zoology, vol. 33, 1919.

(2) Prof. MacBride states that the school to which I apparently belong gives no explanation as to how variations originate, and that "the real problem for science is how 'what is there' came into existence". That is one problem: another is why only a certain proportion of what came into existence survives to be included among 'what is there'. It appears to me that it is with the latter problem that mimetists are primarily concerned, as opposed to the former, which is one for geneticists.

(3) Regarding the influence of food, Prof. MacBride suggests that the study of such factors is the only means of solving the problems of animal coloration.

I would ask him to consider again the last paragraph of section 3 of my article, and whether he would attribute the wonderful similarity in appearance between *Planema* and *Pseudacrœa* to a similar effect of widely different food-plants upon larvæ not at all closely related to each other? G. D. HALE CARPENTER.

Entebbe, Uganda.

Statistics in Biological Research.

AWAY on holiday, I see in my copy of NATURE of July 20, p. 93, a letter on this subject from the distinguished statistician who uses the *nom de plume* of 'Student'. I regret that from some inadvertency he should have dated his letter from the Galton Laboratory, University College, London, an address to which, however much we may regret it, he has no claim. I feel sure that he will recognise, on fuller consideration, that the task of a director of a laboratory would become impossible if anyone could use its address without first obtaining the permission of the director.

KARL PEARSON.