species, it resembles *P. nuptialis,* Gerst., from Texas, and *P. picta,* Hagen, from Smyrna; but it is closer to the latter. In *nuptialis* the inner edge of the apical black area is straight, but in *picta* it is zigzag; in the fossil *arctiiformis* it is as in *picta.*

One of the new plants obtained this year in the Florissant Miocene is of interest in the same connection. It is *Heyderia coloradensis* sp. nov., an incense cedar very closely allied to the living *H. decurrens* (Torrey) K. Koch, of California. The larger leaves are about 5½ mm. long, perhaps less acutely pointed than in the living plant, but in arrangement and general structure quite the same. I follow Dr. N. L. Britton in separating *Heyderia* from the *Libocedrus* of the southern hemisphere; the genus contains two living species, one in California, the other Asiatic. Our fossil agrees very closely with a specimen in the herbarium of the New York Botanical Garden which was collected by Torrey in 1865 in the grove of *Sequoia gigantea* in California. As showing the persistence of a "plant association," it is interesting to note that the fossil species also grew by or under *Sequoia* trees, as is proved by a fragment of *Sequoia haydeni* on the same piece of shale, touching the *Heyderia. Sequoia haydeni,* the Florissant redwood, is the *Hypnum haydeni* of Lesquereux, a fragment of it having been originally described as a moss!

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CENSUS OF FOUR SQUARE FEET

THE approximate numbers of the fruits and seeds, the insects and other invertebrates present on a given area are data for which the student of economic problems has frequent need. It is important, therefore, to have a more accurate conception of the abundance of these items than is derivable from offhand estimates. The present paper is offered as a contribution to the knowledge of this subject, with the explanation that the results herein detailed are not held applicable to any classes of surface other than those examined, nor to any region but that of Washington, where the collections were made. However, it is probable they safely may be used as a basis for reasonable analogies with respect to other localities.

Pausing to note only that the investigation was undertaken primarily because of its relation to the study of bird food, the method used was as follows: areas, two by two feet, of forest floor and of grassy meadow, were examined in November and March, respectively. Everything on the surface of these plots and the ground itself, to the depth a bird easily can scratch, was removed and all plant and animal objects of classes known to be used as food by birds were counted. The following were obtained from the four square feet in the woods: Coleoptera 12, Hemiptera 7, Hymenoptera 8, spiders 11, other Arthropods 26, Annelids 9, Gasteropods 11, cocoons and insect eggs 27, or altogether 112 animal items; in addition there were 194 seeds and fruits. Assuming, as we may in perfect justice, that the plot in question was in no way exceptional, the analysis indicates that on the average there are present on each acre of forest floor in this locality 1,216,880 animals of the kinds above specified and 2,107,810 fruits and seeds.

From the four square feet of meadow there were collected: Coleoptera 61, Hemiptera 20, Hymenoptera 940, spiders 53, other Arthropods 127, Annelids 33, Gasteropods 20, cocoons and eggs 20, or altogether 1,254 animal objects; there were also 3,113 seeds. The averages per acre for meadows, therefore, are: Animals, 13,654,710, and seeds, 33,822,745. On first thought these estimates seem incredible. Hence in order to show that they are the result of the summing up of numbers, individually so small, that no one would question them, I present the following complete lists[1] of the living invertebrates and seeds from each area.

WOODS: INVERTEBRATES: *Chilopoda* 7; *Oligochæta* 9; *Thysanura* (including 1 *Japyx* sp.) 15; *Homoptera* (*Gypona* sp.) 2; *Heteroptera* (*Euschistus fissilis* 2, *E. tristigmus* 1, *Cryphula parallelogramma* 1, *Rhyparochromus* n. sp. 1) 5; *Coleop-*

[1] For the greater part of the identifications of insects the writer is indebted to Messrs. E. A. Schwarz, O. N. Heidemann and Nathan Banks.

tera (*Arthmius globicollis* 6, *Ctenistes piceus* 2, *Sunius prolixus* 1, *Glyphonyx recticollis* 1, *Telephorus* sp. (larva) 1, *Odontota* n. sp. 1) 12; *Lepidoptera* (caterpillars) 2; *Hymenoptera* (*Ponera pennsylvanica* 1, *Aphœnogaster aqua* 1, *Lasius americanus* 6) 8; *Pseudoscorpionida* 1; *Araneida* (*Xysticus transversus* 1, *Ceratinella emertoni* 1, *Anyphœna saltabunda* 1, *Oribata angusticeps* 1, *Philodromus ornatus* 1, *Synemosyna formica* 1, *Ceratinopsis interpres* 1, *Chthonius pennsylvanicus* 1, *Fuentes vittata* 1, *Lycosa pratensis* 1, *Theridula sphœrula* 1) 11; *Acarida* 1; *Gastropoda* 11. Total, 85. Cocoons and Eggs: *Orthoptera* (eggs of *Diapheromera femorata*) 2; *Lepidoptera* (cocoons) 6; *Diptera* (Puparia) 6; *Araneida* (egg sacs) 4; unidentified: 3 eggs; 4 cocoons. Total, 27. Grand total, invertebrates, cocoons and eggs, 112. Seeds: *Juniperus virginiana* 9; *Panicum* sp. 89; *Carex* sp. 1; *Quercus* sp. 2; *Liriodendron tulipifera* 57; *Rubus* sp. 7; *Chamœcrista fasciculatis* 6; *Trifolium repens* 4; other Leguminosæ 17; *Viola* sp. 2; *Cornus florida* 1. Total, 194.

MEADOW: Invertebrates: *Chilopoda* 4; *Oligochœta* 33; *Thysanura* 102; *Homoptera* (*Liburnia* sp. 4, *Agallia 4-maculata* 8, *Tettigoniidæ* 3, *Goniognathus palmeri* 1) 16; *Heteroptera* (*Corimelœna atra* 3, *Capsidæ* 1) 4; *Coleoptera* (*Pterostichus lucublandus* 2, *Stenolophus conjunctus* 1, *Cryptobium pallipes* 1, *Scopœus opacus* 11, *Stilicus rudis* 1, *Erchomus lœviusculus* 5, *Falagria venustus* 1, *Apocellus sphœricollis* 6, *Eucœsthethus americanus* 1, *Philonthus thoracicus* 2, *Tachyporus jocosus* 1, *Diochus schaumii* 6, *Mycetoporus flavicollis* 2, *Trichopteryx haldemani* 6, *Melanophthalma americana* 2, Lampyridæ (larva) 1, Elateridæ (larvæ) 3, *Tomoderus constrictus* 7, *Sitones hispidulus* 1, (unidentified larva 1) 61; *Lepidoptera* (caterpillars) 6; *Hymenoptera* (*Tetramorium cœspitum* 933, *Lasius* sp. 2, *Formica* sp. 1, *Chalcididæ* 4) 940; *Araneida* 53; *Acarida* 15; *Gastropoda* 20. Total, 1,254. Cocoons and Eggs: *Heteroptera* (Pentatomid eggs) 2; *Orthoptera* (grasshopper eggs) 4; other insect eggs 2; unidentified pupa cases 12. Total, 20. Grand total, invertebrates, cocoons and eggs, 1,374. Seeds: *Andropogon* sp. 46; *Panicum* sp. 39; *Chœtochloa viridis* 138; *Eragrostis* sp. 8; *Eulalia zebrina* and other grass seed 2,783; *Allium vineale* (bulblets) 3; *Rumex obtusifolius* 2; *Amaranthus* sp. 4; *Portulaca oleracea* 1; *Pyrus* sp. 1; *Chamœcrista nictitans* 5; *Trifolium repens* 3; *T. pratense* 1; *T.* sp. (sprouting) 18; *Robinia pseudacacia* 6; *Vicia* sp. 1; *Euphorbia maculata* 4; *Vitis* sp. 1; *Verbena urticœfolia* 3; *Paulownia tomentosa* 1; *Ambrosia artemisiœfolia* 1, *Bidens bipinnata* 40; *Sonchus asper* 1; unidentified 3. Total, 3,113.

The most interesting point about the estimates, for the woods and the meadows, aside from their astounding magnitude (contrasted to previous figures based wholly on hypothetical grounds), is the wide discrepancy between them. The population of the meadow is so much more dense than that of the woods. Weighing the items separately, it is easily seen which contribute most largely to the discrepancy. Of the very great number of Hymenoptera (940) found in the pasture, 933 were of one species of ant (the cosmopolitan *Tetramorium cœspitum*). Yet there was no ant colony on the plot; hence direct evidence is lacking that the number found is exceptional. Only 8 ants, however, were found in the forest. Further, the meadow yielded 102 spring tails to 15 in the woods where the decaying leaf mold seems the optimum home. Turning to seeds, it must be admitted that 2,716 of the 3,113 seeds found in the meadow were of a single gramineous species, but this hardly can be termed extraordinary since an abundance of grass seeds must be expected in a meadow. However, to be entirely on the safe side let us subtract these strongly contrasting elements from the totals above stated. Still there remain 397 seeds and 239 animals for the meadow plot, an average of more than double the number secured in the woods.

This result is in harmony with many of the conspicuous phenomena of sylvan and campestran life. Witness the variety and copiousness of the vegetation of roadsides and meadows; their wide expanse of flowers attracts a humming swarm of insects. Enter the deep forest, comparative monotony attends and 'tis quiet as the tomb. As one progresses through the more open woods to the meadows again, step by step, variety and number increase. In no respect are phenomena of this sort better exemplified than in the relative density of the bird population. It is a matter of repeated observation that birds are more abundant in open country, but it has remained for Professor S. A. Forbes first to give the matter definite expression

founded on careful investigation. In his valuable paper of April, 1907, "An Ornithological Cross Section of Illinois in Autumn," the account of a trans-state survey in which 4,804 birds were counted, it is stated that the number of birds per square mile of woods was 785, and in pastures 1,551. While a mere coincidence, yet it is of interest that these figures bear the same relation to each other as do the numbers of the principal food elements.

Another point of interest in connection with the close investigation of the surface fauna relates to dead insects. Insects number so many, that even if we admit, as we do in the case of other animals, the death of each is a tragedy, it stands to reason that this tragedy can not in every case be enacted by captor and prey. Many must die of other causes and simply fall to the ground. What becomes of them? Some are eaten by sarcophagous insects, but are any to be found? The question was raised in the writer's mind by the finding of some suspiciously old and apparently weathered fragments of insects in bird stomachs (segments of Millipeds in the mourning dove, a practically entirely vegetarian species, and of adult June bugs in winter stomachs of some other birds). Were not these possibly picked up as fragments? It is now the writer's opinion that this is more than possible.

At any rate there is no lack of dead insects to be picked up by any bird desiring them. On the plot of forest floor were found nine dead invertebrates entire, and the fragmentary remains of 36. Fewer of such remains were found in the meadow, perhaps because the multitude of ants disposed of a large proportion of them. But even here there were 8 intact bodies and 14 broken. On the basis of these figures there are tangible remains of 240,030 departed insects on each acre of meadow and 488,925 on each acre of woods. Of both the living and the dead there are a host, but the dead of ages reduced to dust are insignificant beside the living of a single season.

W. L. MCATEE

QUOTATIONS

AGRICULTURAL EDUCATION

To one very important condition of success both advocates and opponents of *la petite culture* in England pay, we suspect, too little regard—namely, the improvement of agricultural education, for the heads as well as for the rank and file of the industry. In too many of our country districts it is hardly yet realized that education is necessary at all. Landowner and tenant-farmer are alike disposed to lay blame for the rural exodus on such education as is given to the laboring classes—an education which, it may be admitted, has not always been best adapted to fit them for a country life and pursuits. But they forget that education is, after all, but an incident of the great social and economic changes that have come over English life in the past half century; and that, if all our elementary schools could be restricted to-morrow to teaching "the three R's" and all boys sent out to farm work at ten or eleven years of age, there would still remain the daily newspaper, the bicycle, and the excursion train to give the laborer that wide outlook and "progressive desire" which is what really draws him away from the land. So far from there being, as Squire Oldacre and Farmer Hodge are apt to think, too much education already, what is needed is much more of it, but of a different kind; education in the elementary school that will bear directly on country life and inspire some taste for it; education continued afterwards in evening schools or technical instruction classes to widen the knowledge and sharpen the wits of those who are to cultivate the soil, and to instil into them at least the beginnings of scientific method. The day of rule-of-thumb is over, in agricultural as in other industries; the day of science—that is, of trained and organized knowledge—has begun, and the nation or class that despises it must fall behind. It is not undue treatment in freight charges, or unpatriotic preference for foreign goods, that enables the small Danish butter-farmer, for instance, to undersell the Englishman on his own markets, but superior education and scientific method applied