born left kin and early associates in another land. Such kin are apt to be poor and in any case are hardly likely to send money to support one who migrated to rich America. We can also remember the huge sums our government pays annually in pensions to Civil and Spanish war veterans and their widows, for these must keep many a native out of the poor-house, while a much lesser proportion of foreign-born are helped in that way.

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INVESTIGATIONS OF MAGNETOSTRICTIVE PHENOMENA

IN compiling the data for the various tables to appear in the International Critical Tables under the heading of Magnetostriction it is desired that as complete a survey as possible be made of the literature. In the hope of uncovering all possible sources of materials bearing on the various phases of magnetostriction, this call is sent out asking any one who has reprints of articles covering any particular subdivision of the subject to please send reprints of their work to the undersigned and where reprints are not available will those who have made contributions to this field please send references to the same address?

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QUOTATIONS

POPULAR SCIENCE EXHIBITIONS

Now that the British Empire Exhibition has come to an end—for this year at any rate—it may be of interest to record some impressions of the manner in which the Royal Society's Exhibition of Pure Science, which was arranged in the government building, has appealed to the public, and of the extent to which it has fulfilled the objects with which it was organized.

The arrangement of this exhibition was undertaken by the Royal Society, at the request of the government, for the purpose of showing the essential part played by pure science among the multifarious interests and activities of the empire. Everywhere in the great exhibition the applications of science to industry were to be seen, but the fundamental work of scientific inquiry, in which many of them had their origin, would have been unrepresented unless some special effort had been made to bring it to the public notice. Accordingly, this exhibition, illustrating many aspects of purely scientific research at the present time, and indicating how industry has developed from similar inquiries in the past, was arranged.

The exhibition has not been without its humors. One was the difficulty of returning a satisfactory answer to the inquirer who, after spending some time in the galleries, said, "Yes, but how do you know there is an atom, and how do you know there are electrons inside it?"; and another, the problem presented by a visitor who, on observing that the Milne-Shaw seismograph has a rotating drum giving a record which has to be changed every twenty-four hours, asked, "What happens if there is an earthquake while you are changing the record?"

Nevertheless, it may be said that the exhibition has been an unqualified success. The public, non-scientific as well as scientific, has been really interested, and some, at least, must have gone away with a clearer understanding of the purposes for which men devote their lives to scientific experiment and inquiry. This success may be attributed largely to the policy adopted of making the exhibition a living one. The exhibits were contributed by scientific workers actually engaged in the researches represented, and supplemented where necessary to illustrate a subject fully, by instruments contributed by some of the leading makers. Wherever possible, actual demonstrations were given, and a scientific staff was in attendance throughout to carry out the demonstrations and to explain the exhibits. This policy was fully justified by the continued interest of visitors.

The handbook published in connection with the exhibition has been of great assistance. In this book is made available, for the small cost of a shilling, a series of non-technical articles on current scientific topics by leading authorities; and the best proof of its popularity is the fact that more than two thousand copies were disposed of, while its sale is increasing as it becomes better known, and is likely yet to continue now that the exhibition is closed.

The encouraging success which has met this attempt to present pure science in a less austere light than often surrounds it in the eyes of the general public, leads naturally to the inquiry as to whether a greater use can not be made of scientific exhibitions as a means to this end. Nothing but good can result from such efforts to spread a clear understanding of the true aims and purposes of science. That pure science is the modern expression of the elementary desire for knowledge—for the discovery of natural truths—that it is only by the disciplined quest in unknown fields that those benefits which science gives to the human race can accrue, is too little understood and too easily lost sight of, because of the very magnitude of the results themselves.

It ought to be possible to make an exhibition of this kind an annual event. The Scientific Products Exhibitions, organized by the British Science Guild in

1918 and 1919; the Scientific Novelties Exhibitions held at King's College, London, in connection with the King Edward's Hospital Fund in January 1923 and 1924, and experience at Wembley show that such displays of scientific work and results are much appreciated by the public. The desire for truth is at least as strong and as laudable an inspiration to the human spirit as the desire for beauty, and an event of this kind might well become to the world of science what the annual exhibition of the Royal Academy is to the world of art.

Such an annual exhibition would serve to maintain interest in the work of scientific inquiry, and help to keep it in the public mind in its just relation to the other activities in life. To men of science it might become a valuable auxiliary to the usual methods of publication of new scientific work, by reaching a wider public than the transactions of the scientific societies or the scientific periodicals can ever hope to do; and to the museums, it could be a source from which to obtain objects of interest from time to time, and thereby do much to prevent such national misfortunes as, for example, the dispersal, during the war, of the apparatus used by H. G. J. Moseley in his historic work on the X-ray spectra of the elements. It is to be hoped, therefore, that whatever facilities or funds are required to secure the continuance of the pure science exhibits and demonstrations now at Wembley will be provided.—*Nature.*

SPECIAL ARTICLES

PERIODIC REVERSAL OF HEART-BEAT IN A CHRYSALIS[1]

WHILE recently[2] studying two freshly formed chrysalids of *Colias eurytheme,* the cuticula of which was still transparent, I noticed that the heart was beating forward in one, as in insects generally, while in the other the direction of the beat was backward. This extraordinary phenomenon led me to watch the heart action of many pupae individually under a binocular dissecting microscope.

The profound internal changes in form of the mature caterpillar when it stops feeding and hangs itself up to shed its skin and become a chrysalis are accompanied by a periodic reversal in the direction of the peristalsis of the dorsal vessel. Beneath the larval skin the mature caterpillar is now wasp-waisted like the butterfly, and its wing buds are well formed. Its heart action then becomes essentially like that of the pupa, which, briefly, is as follows:

A period of rapid pulsation forward at the rate of approximately one wave of peristalsis per second is followed by a pause of 2 to 3 seconds. Then a slower pulsation at the rate of about one beat in two seconds and lasting for about 12 beats (25 seconds) occurs in *both directions,* forward from the third and backward from the fourth abdominal segments. Then the forward wave through the thorax usually stops altogether, and the whole dorsal vessel slowly pulsates backward at the same rate (about 0.5–0.6 beat per second). Toward the end of each phase just preceding reversal, the rate slackens slightly, but in the reversal to run *forward* there is little hesitation. The quick pumping forward is resumed without the noticeable pause that occurs at the end of the forward movement.

The number of beats forward and backward is subject to much variation, but in general the proportion of backward beats to forward increases with age.[3] Thus two larvae ready to pupate gave averages of 29.5 per cent. and 29.2 per cent. beats backward while two pupae, one fresh and one older, gave 41.3 per cent. and 59.2 per cent. backward. They beat as follows:

	Beats backward	Beats forward	Percentage backward	Temperature.
Mature larva	71	169	29.5	21° C.
" "	47	114	29.2	21° C.
Fresh pupa	78	111	41.3	25° C.
Older pupa	180	124	59.2	21° C.

It should be noted that in the two pupae just mentioned the first 10 to 15 strokes of the "backward" movements were mixed, including a forward pulsation through the thorax.

Another older chrysalis gave 238 beats backward to 196 forward (54.8 per cent. backward), the proportion of backward beats to forward showing no further increase but rather diminishing slightly as the number of beats in each phase lengthened; the backward beats in this pupa slackened to 0.33 beat per second, whereas the forward movement maintained a high rate (1.05 beat per second, temp. 24° C.)

The flow in the caterpillar up to the time when it stops feeding and prepares to pupate is always forward. This was true of every individual observed, but whether moulting affects the direction of circulation in the younger larval stages has not yet been determined. Since the hæmolymph is strongly colored, the outline of the dorsal vessel is clearly visible without a lens, as a dark green median-dorsal band against a paler green background. Closer examination shows that the dorsal vessel lies close to the

[1] Research promoted by a grant from the Joseph Henry Fund.

[2] October 21, 1924.

[3] Exact counts with a stop-watch have been made upon eleven individuals. Thanks are due to Arthur M. Crosman, Joseph H. Berwick, K. W. Weeks, A. H. Lowell and L. J. Obermeier, who have served as timekeepers.