

RESPIRATION AND THE ASSIMILATION OF CARBON DIOXIDE

AN account of work by C. H. Werkman, L. O. Krampitz and R. G. Wood of Iowa State College on the assimilation of carbon dioxide during respiration was given on October 13 during the Autumn Meeting of the U.S. National Academy of Sciences.

The concept of heterotrophic assimilation of carbon dioxide was first established in 1935 by Wood and Werkman, while investigating the dissimilation of glycerol with the propionic acid bacteria. They observed the molar correlation between carbon dioxide disappearance and succinic acid formation and proposed the reaction: $\text{pyruvate} + \text{CO}_2 \rightarrow \text{oxaloacetate}$, to account for this fixation of carbon dioxide. The latter four-carbon dicarboxylic acid serves as the oxidizing agent for the glycerol, resulting in the formation of succinic acid.

The concept of carbon dioxide assimilation has recently been applied to many other heterotrophic forms, including the liver tissue of mammals. It is in this tissue that the role of carbon dioxide fixation has been shown to be of fundamental importance with regard to respiration. Oxaloacetate is the cardinal compound in the main respiratory mechanism of the tissue. Consequently elucidation of the mechanism of its formation is of fundamental importance. Direct evidence for the fixation reaction has been obtained with a bacterial enzyme preparation from *M. lysodeikticus*, which is capable of bringing about the decarboxylation of oxaloacetate, that is, the reverse of fixation reaction. Thus far attempts to carboxylate pyruvate have failed. This may be due to an unfavourable equilibrium, that is, the breakdown of oxaloacetate is greatly favoured. On the other hand, pyruvate as such may not be the compound with which carbon dioxide unites but rather a derivation of pyruvate. With ^{13}C as a tracer it was possible, however, to demonstrate the fixation reaction using oxaloacetate. Decarboxylation of oxaloacetate was carried out in the presence of the enzyme and NaHCO_3 with an enriched ^{13}C content. The reaction was allowed to continue until the original oxaloacetate concentration was halved. The residual carbon dioxide was removed and the remaining oxaloacetate was decarboxylated to pyruvate and carbon dioxide and the latter thus obtained determined for ^{13}C . The concentration of ^{13}C was substantially above normal.

The criticism that a chemical exchange of carbon dioxide with carboxyl group, analogous to the exchange of deuterium with ionizable hydrogen, may take place was investigated. Oxaloacetate spontaneously decarboxylates slowly. An experiment similar to the above one was performed omitting the enzyme, and the residual oxaloacetate decarboxylated. The ^{13}C content of this carbon dioxide was normal.

The possibility of the enzymatic exchange of carbon dioxide with carboxyl groups of other keto acids was investigated, with an enzyme capable of oxidizing pyruvate to acetate and carbon dioxide. An experiment was conducted in which the oxidation was permitted until one half of the pyruvate remained. The residual pyruvate was decarboxylated and the ^{13}C content of the carbon dioxide was found normal. Similarly, the oxidation of α -keto glutarate to suc-

inate was carried out, and likewise the normal ^{13}C content of carbon dioxide obtained.

Thus it has been demonstrated that the exchange reaction is specific for oxaloacetate, and apparently does not occur in other keto acids. The exchange reaction in oxaloacetate is essentially 3- and 1-carbon addition or a fixation reaction.

GAME PRESERVATION IN BURMA

THE annual report on game preservation in Burma for the year ending March 31, 1940 (Rangoon, Supt. Govt. Printing, Burma, 1941) shows that this matter is treated in Burma with the serious spirit it demands. The present policy aims at providing a sufficient number of sanctuaries to ensure that no species of Burman bird or animal becomes extinct. The following list of sanctuaries will indicate how this laudable effort is carried out under the able game warden, a member of the Burma Forest Service. It is a pity that India as a whole and the British Colonies have not made similar attempts at game preservation. There are seven sanctuaries situated in North and South Burma: Pidaung (Myitkyina), 278 sq. miles; Shwe-u-daung (E. Katha), 81 sq. miles, with another 45 sq. miles situated in the neighbouring Federated Shan States; Maymyo (summer headquarters of Government of Burma), 49 sq. miles; Moscos Islands (Tavoy), 19 sq. miles; Kahilu (Thaton), 62 sq. miles; Mulayit (Thaungyin), 53 sq. miles; Wetthigan (Minbu), $1\frac{3}{4}$ sq. miles.

The Pidaung sanctuary is primarily constituted to protect elephants, bison, saing, sambhur, hog deer, pig, tiger, leopard, bear, pea-fowl, pheasant, jungle fowl, partridge and quail. Of these it is reported that elephant, bison and saing continue to increase, though elephants only spend part of their time in the sanctuary. On the other hand, there is a marked reduction in sambhur and hog deer found in the open plains; this is attributed to tigers and wild dogs. Four tigers are to be shot by the keepers of the sanctuary and as many wild dogs as possible, as also crows which are a serious pest to bird life in the sanctuary. Those acquainted with big-game shooting in India must have noted at times the results of the wild dog pest—whole jungles deserted by game once the animals are aware of the advent of parties of wild dogs.

The Shwe-u-daung sanctuary contains the above mentioned fauna, with the addition of *Rhinoceros sumatrensis* and the serow. There is reason to believe, says the warden, that the small band of Sumatran rhinoceros living in this sanctuary has become well established, and the evergreen hill forests covering the upper slopes of the sanctuary provide an undisturbed area where these animals can live in peace. The increase in wild dogs is giving trouble here. In the Kahilu sanctuary the animals are *Rhinoceros sumatrensis*, serow, sambhur, barking deer, mouse deer, hog deer and jungle fowl. It has been proved that the rhinoceros in this sanctuary is *R. sumatrensis* and not *R. sondaicus*, as identified some years ago from skulls by the Bombay Natural History Society. The Sumatran rhinoceros is an extremely rare animal in Burma.

Of the other sanctuaries the Maymyo contains barking deer, jungle fowl, partridge and pea-fowl; Moscos Islands, sambhur, barking deer and pig; Mulayit, barking deer, pig, tiger, and leopard; and the latest made sanctuary, the Wetthigan, which