Table 1. Pressure-temperature conditions used in synthesis of B-type sesquioxides.

Sesquioxide	Pressure (kb)	Temp. (°C)
Yttrium	25	1000
Samarium	30	1020
Europium	25	905
Gadolinium	30	1020
Terbium	25	905
Dysprosium	30	1020
Holmium	25	1000
Erbium	30	1020
Thulium	40	1005
Ytterbium	40	1000
Lutetium	40	1005

* Heating time 30 minutes.

samples were quenched within a few seconds to approximately 50°C by turning the power off. Pressure was then released gradually over a 5- to 10-minute period. Samples were subsequently investigated at ambient conditions by x-ray diffractometer and film techniques.

We have prepared and retained at ambient conditions the B-modification of all previously unknown heavy rare-earth sesquioxides—Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, and Lu_2O_3—and the B-form of Y_2O_3. Our experiments also indicate that the B-form of europium, gadolinium, terbium, and dysprosium sesquioxides can be prepared at substantially lower temperatures at high pressure than at atmospheric pressure. The conditions under which the new B-phases were synthesized are listed in Table 1.

Preliminary calculations for the lattice constants of the new phases (*12*) indicate that they agree with those predicted by extrapolation of previously known B-type sesquioxide parameters under consideration of the lanthanide contraction of the trivalent ions. The volume per R_2O_3 molecule obtained for these phases is included in Fig. 1.

Reversibility of the pressure-induced phase changes was checked for all B-type phases reported in Table 1 by heating them in air at 1000°C for several hours. Under these conditions all sesquioxides with the exception of those of europium and gadolinium reverted to the C-modification. This shows that the C → B pressure transformation is reversible for all new B-type phases and confirms the results of others on the pure dry samples of previously known B-type sesquioxides.

At present we are studying the temperature-pressure conditions under which the reversible C ↔ B transformation takes place for the various sesquioxides. Qualitative conclusions concerning the effect of pressure on the transformation temperature of a given oxide and the effect of the ionic radius can be derived from the experimental conditions listed in Table 1 and from the observation that, at 25 kb and 1000°C, C-type thulium sesquioxide did not transform into the B-modification and that, at 30 kb and 1000°C, only a small fraction of C-type ytterbium sesquioxide transformed into the B-modification. Thus, high pressure lowers the transformation temperature of a given sesquioxide whereas decreasing ionic radius of the metal component of the sesquioxide increases the transformation pressure.

We do not, at this time, have direct evidence for a B → A conversion in any of the samples investigated. Poor crystallinity of Sm_2O_3 samples heated at about 50 kb suggests that transformation to the hexagonal phase was imminent or that it had occurred but reverted to the monoclinic phase on release of pressure.

Our results reopen the problem of the polymorphy of the rare-earth sesquioxides by including pressure as a new variable. They prove that more rare-earth sesquioxides than had previously been expected can stably exist in more than one crystalline form. They confirm the enantiotropic nature of the C ↔ B transformation as advocated by Roy and co-workers (*6*, *7*), and show a wide occurrence of the monoclinic sesquioxide structure. It is likely that other C-type oxides, such as the thallium and indium sesquioxide, may form the B-modification at high pressures. Further work may also lead to reversible transitions between the A and B types and possibly the A- and C-modifications. The new B-type sesquioxides reported here appear to be true high-pressure phases which are metastable at atmospheric pressure at all temperatures. A possible exception is B-type yttrium sesquioxide, which may form between 2000°C and its melting point.

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Mayfly Distribution Indicates Water Quality on the Upper Mississippi River

Abstract. *Hordes of mayflies emerge during the summer months from most sections of the Upper Mississippi River, thus creating nuisance problems for shoreline residents and river traffic. The presence of these pollution-sensitive forms indicates, however, that the river is more river-like than sewer-like in a given area.*

People who live along most of the Upper Mississippi River are accustomed to periodic invasions by hordes of mayflies (Insecta: Ephemeroptera). Tree limbs droop under their weight, and drifts of the insects form under street lights where they decay and create objectionable odors. Shoppers desert downtown areas as the large, clumsy insects fly in their faces, cover windows, and blanket sidewalks. In extreme cases snowplows are called out to reopen highway bridges which have become impassable. Particles of cast mayfly cuticle cause allergic reactions in some people (*1*). Mayflies become a hazard to navigation when they are attracted by the powerful arc and mercury-vapor searchlights used by towboats to spot unlighted channel markers.

An analysis of data collected over a 7-year period indicates, however, that the systematic collection of pollution-sensitive species such as the mayfly can provide a reliable and economical method for determining the state of well-being of a river. It is ironic that the mayflies which are cursed by many river residents are excellent indicators, by their mere presence, that the Mississippi River is more river-like than sewer-like in a given area. If adequate pollution control measures are not initiated as populations increase, nuisance mayfly problems may resolve themselves.

Mayflies are known by many colloquial names such as fish-flies, riverbugs, willowbugs, Green Bayflies, Canadian soldiers, Mormonflies, shadflies, and Junebugs. The principal species which cause annoyance along the Upper Mississippi River are *Hexagenia bilineata* (Say) and *Hexagenia limbata* (Serville). A third species, *Pentagenia vittigera* (Walsh), is much less abundant but still adds occasionally to the total nuisance problem.

The life histories of the two species of *Hexagenia* are well known (*2*). The biology of *Pentagenia vittigera* is little known, but its life history is probably similar to that of the *Hexagenia* species. Adult *Hexagenia* mayflies mate aerially, and the females return to the water where each deposits about 8000 minute eggs. The eggs hatch in about 12 days and the newly hatched microscopic nymphs burrow into the mud, where they remain for most of their lives. The burrows, which are U-shaped, serve as respiratory devices as the nymphs pump water through them by means of undulatory gill movements.

Hexagenia nymphs provide an important source of food for fish in the Upper Mississippi River (*3*) and are generally considered to be pollution-sensitive forms (*4*). They mature in about a year and rise to the surface of the water, usually at night, where they moult to become winged subimagoes (subadults). The subimagoes shed their exuviae later the same day to become imagoes, which mate and die within a few hours. The flight range of imagoes is generally quite short, but egg-laying females may occasionally fly as far as 20 km before ovipositing (*5*).

A program was begun in 1957 to learn more about the biology of the *Hexagenia* mayflies of the upper Mississippi River. Materials for collecting mayflies were provided to towboat captains and lockmasters at each of the 27 locks on the navigable portion of the upper Mississippi (*6*). Cooperators were asked to collect specimens each time they encountered a mass emergence of mayflies and to record the date, time, and location (mile number). During the summers of 1957 through 1963, 576 collections were made of the three aforementioned species between Minneapolis and the confluence of the Mississippi and Ohio rivers. Collectors have more recently (1960 through 1963) been enlisted along the Mississippi from Minneapolis northward to the source of the river at Lake Itasca, Minnesota. When all records of mass emergence were plotted by mile (Fig. 1) it became obvious that two areas of the navigable portion of the Upper Mississippi River failed to produce large numbers of mayflies. These areas (immediately down-river from the Twin Cities and St. Louis) are also of interest from a pollution standpoint.

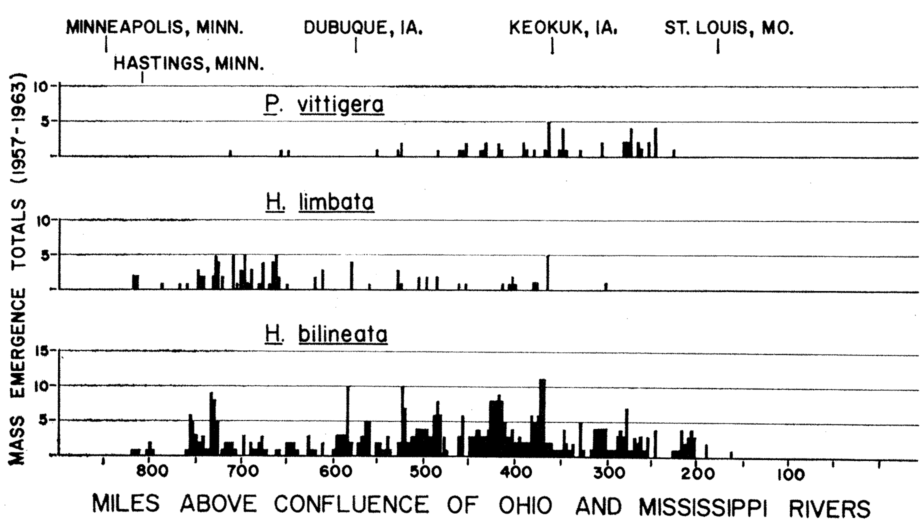

Fig. 1. Total mass emergences of *Hexagenia bilineata, Hexagenia limbata,* and *Pentagenia vittigera* mayflies as determined by collections made along the Upper Mississippi River during the years 1957 through 1963.

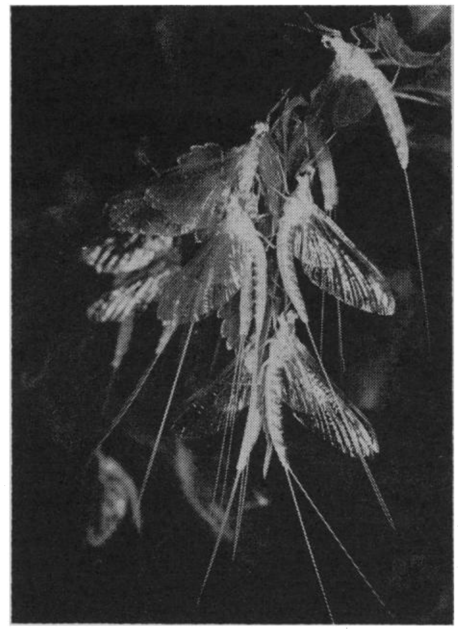

Fig. 2. *Hexagenia limbata* mayflies resting in the shade prior to forming their evening mating swarm.

The area from Minneapolis to Hastings, Minnesota, was seriously polluted as early as 1929 (*7*), and in a contemporary report (*8*) it is stated that about 20 million gallons (75 million liters) of wastes from industrial process sources and about 200 million gallons of sewage from 29 treatment plants presently enter the river in the Minneapolis area daily. Approximately 24 million gallons of treated and untreated municipal and industrial wastes are also added daily by the Minnesota River. Raw domestic sewage enters the river from the Twin Cities area during periods of high surface run-off because much of the Twin Cities area has a combined sewer system which must accommodate both sanitary sewers and storm sewers. During periods of high surface run-off the plants cannot accommodate the total volume and are bypassed.

No records exist for mass emergences of any of the three mayfly species in the 30-mile (48 km) section down-river from Minneapolis. *Hexagenia bilineata* is common, however, in the Mississippi River above Minneapolis, and mass emergences have been reported at St. Cloud and Brainerd. Mass emergences of *H. limbata* have been recorded upstream from Minneapolis at Little Falls, Aitkin, Cass Lake, and Bemidji.

Lake Pepin, which is about 23 miles (37 km) long and 2 to 3 miles (3 to 4 km) wide, evidently serves as a settling basin for much of the pollutants from the Twin Cities area which lies 40 miles (64 km) up-river. Midge larvae (Diptera: Tendipedidae) which are tolerant of low oxygen concentrations presently occupy much of the lake bottom in lieu of burrowing mayflies. Adult midges constitute more of a nuisance than do mayflies in this area. The lack of current in the lake probably allows an oxygen deficiency to develop in the thin layer of water at the mud-water interface where burrowing mayflies obtain their respiratory water. Such an oxygen deficiency has been suggested to be a limiting factor for benthic invertebrates in similar habitats (*9*). Mass emergences of *H. bilineata* or *P. vittigera* have not been recorded from the lake. One mass emergence of *H. limbata* has been recorded.

Many industries add wastes to the Mississippi River in the St. Louis area (*10*). As of December 1962, raw domestic sewage entered the Mississippi River or its tributaries in the St. Louis area from the following population centers: Keokuk, Iowa; Alton, Illinois; St. Louis, Missouri; East St. Louis, Illinois; Jefferson City and Cape Girardeau, Missouri; and Cairo, Illinois. Most of these cities now have treatment plants in progress or in the planning stage.

No mass emergences of *H. limbata* and *P. vittigera* and only one emergence of *H. bilineata* have been reported below St. Louis. It seems very unlikely that St. Louis is merely the southern limit of the range of the three species in the Mississippi River, because *H. bilineata* and *P. vittigera* have been collected as far south as Florida (*11*) while *H. limbata* has been collected as far south as central Texas (*12*) and southern Mississippi (*13*).

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Insulin Action in Alloxan Diabetes Modified by Actinomycin D

Abstract. *Insulin corrects the disturbances in lipid and carbohydrate metabolism in rats made diabetic with alloxan. However, the concomitant administration of actinomycin D with insulin prevents the repair of enzymatic defects in the syntheses of total fatty acids by adipose tissue, of monounsaturated fatty acids by liver microsomes, and of hepatic glycogen. The hypoglycemic action of insulin in diabetes is not modified by actinomycin injections. These findings indicate that a fundamental mechanism of action of insulin is the induction of enzyme synthesis through stimulating the renewal of cellular RNA.*

Since the observations of Stetten and Boxer (*1*) it has been recognized that a major metabolic disturbance in diabetes is a suppression of the biosynthesis of fatty acid from acetate (*2*). We have described another impairment in lipid metabolism in diabetes characterized by a striking depression of the biosynthesis of monounsaturated fatty acids from either acetate or saturated fatty acids (*3*). In mammalian cells, olefin synthesis is principally localized to a microsomal enzyme system which is dependent upon molecular oxygen and reduced pyridine nucleotide (DPNH or TPNH) (*4*). In diabetes, microsomal desaturation of long-chain saturated fatty acids virtually ceases, but the defect is readily repaired by the administration of insulin (*5*). We now report the effect of actinomycin D, administered with insulin to rats made diabetic with alloxan, on the synthesis of olefins by liver microsomes, on the total fatty acid synthesis in adipose tissue, on the formation of liver glycogen, and on the blood-sugar concentration. The evidence indicates that insulin induces enzymes concerned with the synthesis of saturated and monounsaturated fatty acids and of glycogen by stimulating the renewal of cellular RNA. The hypoglycemic action of insulin is not related to new enzyme synthesis.

Male Wistar rats (150 g) of the Chester Beatty colony were divided into four experimental groups: (i) normal, (ii) untreated diabetic, (iii) insulin-treated diabetic, and (iv) insulin plus actinomycin-treated diabetic. All animals received food as desired, and the drinking water contained 5 percent dextrose. The diabetes, produced by subcutaneous injection of alloxan at least 14 days prior to experimentation, was stable as indicated by a persistent glycosuria (4 plus) and hyperglycemia (300 mg per 100 milliliters of blood or higher). Therapy with glucagon-free insulin was given in three doses of five units each subcutaneously during the 26 hours immediately prior to the experiment. Actinomycin D in doses of 5 to 25 μg per 100 grams of body weight was injected intraperitoneally ½ hour before each insulin injection.

Blood sugar was determined by the glucose oxidase method (*6*). Liver glycogen was measured by the phenol sulfuric acid method (*7*). The biosynthesis of total fatty acid was measured in vitro in the epididymal adipose tissue with acetate-1-C^{14} as substrate (*8*). Liver microsomes were obtained by differential centrifugation. Olefin synthesis was determined by the conversion of stearic acid-1-C^{14} to oleic acid-1-C^{14} during a 20-minute incubation at 37°C in 3 ml of