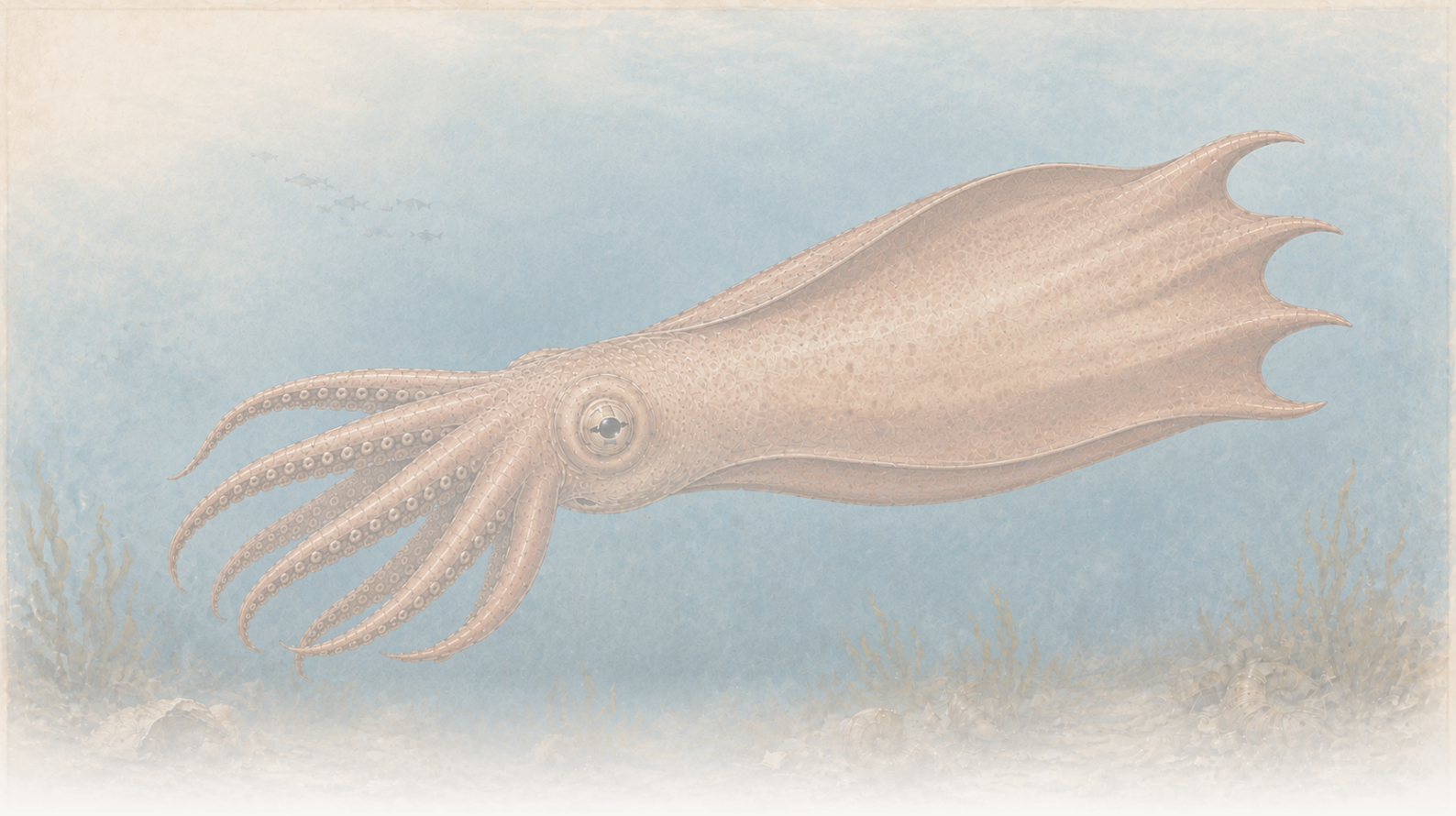




The CLEAN PAPER

WHAT THE PAPER SAYS · WHAT IT DOESN'T · WHY IT MATTERS

Giant Cretaceous octopuses watakila sun kasance top predators — amma evidence yana farawa da jaws, ba sea monsters ba

Wani paper a Science ya sake nazarin manyan Cretaceous cephalopod jaws kuma ya yi hujjar cewa species biyu na Nanaimoteuthis early finned octopuses ne, tare da body-size estimates da suka kai several meters kuma possibly har 18.6 m. Heavy jaw wear yana suggest hard-prey crushing; asymmetric wear na iya hint lateralized behavior. Spectacular fossil story ne, amma clean version ba “kraken ya kasance real” ba ne: reconstruction ne daga jaws, wear patterns, taxonomy da scaling.

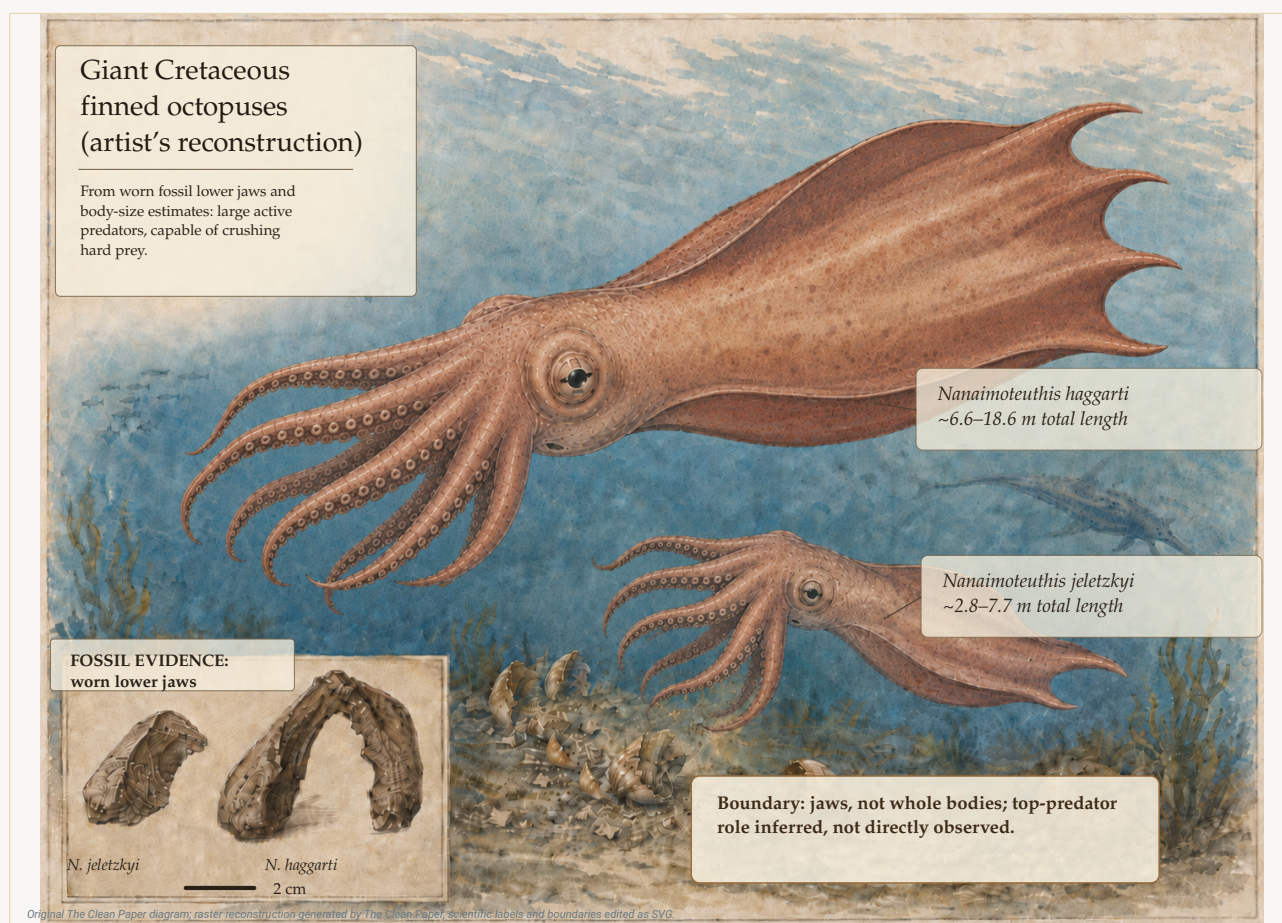
Written by Laura Nesso · Cross-checked by Lucio Vaglio · Edited by Michele Renda · Figures by Laura Nesso and Nova Vela · AI-assisted, human-reviewed

Paper: *Earliest octopuses were giant top predators in Cretaceous oceans*, Shin Ikegami, Jörg Mutterlose, Kanta Sugiura, Yusuke Takeda, Mehmet Oguz Derin, Aya Kubota, Kazuki Tainaka, Takahiro Harada, Harufumi Nishida, and Yasuhiro Iba, Science 392, 406–410 (2026) · DOI: 10.1126/science.aea6285

Labarin kraken, idan aka mayar da shi ga burbushin da muke da shi

Fossil jaw ba dabba gaba ɗaya ba ce. Kaƙkarfan ragowar soft body ne, fragment da paleontologists dole su yi amfani da shi su reconstruct anatomy, behavior da ecology ba tare da yin kamar sun ga dabbar da rai ba. Shi ya sa wannan takarda yana da jan hankali sosai kuma yana da sauƙin oversimplify. kanun labarai mai sauƙi zai ce: giant kraken-like octopuses sun mamaye tekunan Cretaceous. Version mai hankali ya fi kyau: fossil jaws da aka adana sosai suna nuna cewa wasu daga earliest known finned octopuses manyan carnivores ne, suna crush hard prey akai-akai, kuma wataƙila sun kai saman food webs na Late Cretaceous.

Wannan ma abin mamaki ne. Amma ya kamata a karanta shi a matsayin reconstruction daga jaws, wear patterns, taxonomy da body-size scaling — ba sea-monster story ba.



Artist's reconstruction na nau'ikan **Nanaimoteuthis** biyu da takardar ta tattauna, tare da fossil lower jaws a matsayin direct shaida da body-size reconstruction ya dogara da shi. Hoton reconstruction ne, ba fossil photograph ba: preserved shaida jaws ne, yayin da body length da top-predator role inference ne daga scaling, wear patterns da ecology.

Original hybrid diagram — The Clean Paper CC BY 4.0

Abin da marubutan suka yi

Marubutan sun sake nazarin fossil jaws daga Cretaceous octobrachian cephalopods — babban group da ya haɗa octopuses da danginsu. An riga an ruwaito manyan fossil jaws 15 daga Japan da Vancouver Island. Kungiyar ta kuma gano karin jaws 12 a carbonate concretions guda biyar daga Japan ta digital fossil-mining.

Wannan method ya haɗa high-resolution, full-color grinding tomography da zero-shot learning AI model, wato sam-furin ba a train musamman ga waɗannan fossils ba. Masu binciken sun grind kowane concretion a **50-micrometer intervals**, suna daukar hoto na kowane sabuwar surface don gina large sequence na color images. Segmentation model mai suna DEVA ya samar da digital outline, ko mask, na jaw a kowane image. Masu binciken sun duba outlines ɗin da original images, sannan suka stack da join su zuwa minimally smoothed, original-color 3D models. Hakan ya ba su damar gano jaws da ke boye cikin rock da kuma duba fine chips, scratches da sauran wear features a surface. Grinding tomography ya lalata rock samples biyar, amma image bayanai, masks da 3D models da aka samu an archive su.

Sannan suka yi abubuwa huɗu masu haɗuwa.

Na farko, sun revised taxonomy. Fossil jaws da aka raba a species biyar a baya an sake shirya su zuwa species biyu: **Nanaimoteuthis jeletzkyi** da **Nanaimoteuthis haggarti**. Genus ɗin, wanda a baya aka dauka a matsayin vampire-squid relative, a nan an sanya shi cikin **Cirrata**, finned octopuses.

Na biyu, sun tsawaita timeline. Sabon material ya tura **N. jeletzkyi** zuwa earliest Cenomanian, kusan **shekaru miliyan 100 da suka wuce**, yana tsawaita known record na finned octopuses da kusan shekaru miliyan 15, da octopuses gaba ɗaya da kusan shekaru miliyan 5.

Na uku, sun kiyasta body size daga jaw size. Ta amfani da allometric relationships daga modern long-bodied finned octopuses, sun kiyasta mantle length sannan total length. Estimates ɗin suna da faɗin range: **N. jeletzkyi** kusan **mita 2.8 zuwa 7.7** total length, **N. haggarti** kuma kusan **mita 6.6 zuwa 18.6**. Wannan upper range shi ne tushen “kraken” language.

Supplementary methods sun bayyana scaling chain ɗin. Masu binciken sun reconstruct worn ko weathered jaw outlines inda ya dace, sannan suka yi amfani da **species-specific relationships 12** tsakanin lower-jaw hood length da mantle length. Sun account matsakaici **39% fixation shrinkage** a relevant modern specimens, sannan suka canza mantle length zuwa total length da ratio **4.2** daga long-bodied living finned octopuses. Waɗannan choices suna samar da range, ba direct measurement na fossil body ba.

Na huɗu, sun duba wear. Manyan jaws sun zama blunt da rounded a wuraren da juveniles za su fi sharp jaw elements. Sun nuna chips, scratches, polished surfaces, cracks, da asymmetric loss na jaw edges. Marubutan suna interpret wannan a matsayin shaida na repeated hard-prey crushing, da possibly lateralized behavior.

Abin da suka gano

Mai yiwuwa early finned octopuses ne, ba vampire squids ba. Supplementary taxonomy ta raba linked steps biyu. Kowane bridge strip ne na jaw material da ke haɗa hood da lateral wall. A **Nanaimoteuthis**, waɗannan bridges inner da outer jaw plates suna boye su gaba ɗaya, pattern da ke goyon bayan sanya genus a Cirrata. Broad

jaw wings d'insa sannan suna goyon bayan sanya shi a long-bodied group na finned octopuses. Wannan yana da muhimmanci saboda takarda ba kawai yana cewa “large cephalopod” ba; yana canza inda fossils suke zaune a octopus history.

Sun yi tsufa sosai. Sabbin specimens suna sanya finned octopuses kusan **shekaru miliyan 100 da suka wuce**, a Cretaceous. Hakan ya sa su cikin earliest octopus-line animals da aka sani.

Za su iya kasancewa manya kwari. Body-size estimates ba measurements na preserved bodies ba ne; calculations daga jaws ne. Amma numbers suna da girma ko an fada da hankali. Smaller species, *N. jeletzkyi*, an kiyasta shi da several meters total length. Larger *N. haggarti* an kiyasta har kusan **mita 18.6**, comparable in scale da manyan marine predators na lokacin da kuma manyan living cephalopods.

Jaws sun yi wear sosai. A largest specimens, lost jaw material ya kai kusan **10% na total jaw length**. takarda yana cewa wannan wear ba preparation damage ko transport abrasion ba ne: specimens sun fito daga low-energy outer-shelf deposits, chips da scratches an preserve su a patterns da suka dace da amfani, kuma co-occurring fossil squid jaws ba su nuna irin pattern din ba. Marubutan sun kwatanta wear da modern durophagous cephalopods — animals da ke cin hard prey.

Wear din asymmetric ne. Right jaw edge ya fi left wear a species biyu. Marubutan suna interpret hakan a matsayin mai yiwuwa behavioral lateralization: preference na amfani da side guda fiye da daya. Saboda lateralized behavior yana associated da complex nervous systems a modern animals, suna nuna cewa wadannan early octopuses watakila sun riga sun yi advanced intelligence.

Abin da wannan mai yiwuwa yake nufi

Strongest ecological interpretation shi ne Late Cretaceous finned octopuses ba duk small background animals ba ne a ecosystems da large vertebrates suka mamaye. Top-predator case na marubutan ya hada gigantic estimated body size da durophagous carnivory — repeated processing na hard animal prey — inferred daga jaw wear. Tare, wadannan findings suna goyon bayan possibility cewa invertebrate lineage ta shiga top tier na food web da ake hadawa da mosasaurs, plesiosaurs, large fish da sharks.

Evolutionary story ma yana da ban sha'awa. Vertebrate marine predators da octopus-line cephalopods sun bi hanyoyi daban-daban zuwa predation. Vertebrates sun samu jaws, streamlined bodies, kuma galibi suka rage external armor. Octopus relatives sun rage ko internalize shells, suka zama soft-bodied da mobile, yayin da suka riƙe powerful jaws da flexible arms. takardar ta frame wannan a matsayin convergent path zuwa large, intelligent marine predators.

Part mafi speculative shi ne behavior. Extensive wear yana goyon bayan hard-prey feeding. Large size yana goyon bayan ecological importance. Asymmetric wear yana goyon bayan mai yiwuwa lateralized behavior. Amma “advanced intelligence” inference ne, ba direct fossil measurement ba. mai yiwuwa ne cikin context na octopus biology, amma bai kamata a kara karfinsa fiye da shaida ba.

Abin da wannan ba ya tabbatar

- Ba ya preserve whole giant octopus body. Reconstruction ya dogara ne musamman da jaws, tare da body size inferred daga modern finned-octopus scaling.
- Ba ya nuna stomach contents ko direct prey remains. Hard-prey feeding inference ne daga jaw wear, ba fossilized meal ba.
- **Authored research article** ba ya propose cewa sun ci mosasaurs, plesiosaurs, ko other large marine reptiles. Research text ya ambace su ne kawai a matsayin comparisons na body size da ecological position.
- Ba ya ba exact body length. Estimates ranges ne, kuma largest ikirari upper estimate ne.
- Ba ya auna intelligence kai tsaye. Lateralized jaw wear an interpret shi a matsayin mai yiwuwa behavioral lateralization, wanda zai iya suggest complex behavior; wannan several inferential steps ne daga sanin abin da dabbar za ta iya yi.
- Ba ya nufin duk early octopuses giants ne. ikirarin ya shafi waɗannan *Nanaimoteuthis* species, musamman *N. haggarti*, ba kowace early octopus lineage ba.

Yaya karfin shaidar yake?

Ga existence na very large Cretaceous octopus-line jaws, shaida yana da karfi: takardar ta gabatar da described specimens, digital models, stratigraphic context, da comparisons da modern da fossil cephalopod jaws.

Ga hard-prey feeding, shaida ma reasonably strong ne. Wear patterns suna detailed — chips, scratches, polish, cracks, asymmetric loss — kuma marubutan sun yi kokari wajen exclude preparation damage da transport abrasion. Comparison da modern durophagous cephalopods mai yiwuwa bridge ne.

Ga exact body size da top-predator status, confidence ya kamata ya zama moderate. Size estimates sun dogara da allometric scaling daga living long-bodied finned octopuses. Ecological role inference ne daga combination na estimated size da durophagous carnivory, ba direct observation ba. Argument d'in coherent ne, amma ecological reconstruction ne, ba direct census na food web ba.

Me ya sa yake da muhimmanci

Wannan takarda kyakkyawan misali ne na yadda paleontology ke yin strong ikirarai daga partial shaida ba tare da sihiri ba. Jaw shi ne object. Wear behavioral trace ne. Scaling curve bridge ne daga hard fossil zuwa soft body. Kowane step yana kara power, kuma kowane step yana kara uncertainty. Wannan shi ne darasin da ya dace a rife.

Har ila yau yana gyara familiar picture. Cretaceous oceans galibi ana hango su a matsayin duniyar big vertebrate predators da smaller shelled prey. Waɗannan fossils suna nuna cewa wasu soft-bodied invertebrates ba kawai suna boye a karkashin food web ba. Watakila suna compete a upper levels.

Sakamakon visual ne sosai, amma clean story ba “kraken ya kasance real” ba ne. Shi ne cewa large, early finned octopuses sun bar jaws da researchers suka reconstruct gigantic bodies da repeated hard-prey feeding daga gare su — combination da ke yin serious, amma har yanzu inferential, case ga invertebrate top predators a zamanin

marine reptiles.

Takaitaccen bayani mai tsabta

Masu bincike sun sake nazarin Cretaceous fossil cephalopod jaws daga Japan da Vancouver Island, kuma sun yi amfani da full-color grinding tomography plus zero-shot AI segmentation don digitally reconstruct hidden jaws a matsayin detailed 3D specimens daga rocks na Japan. Sun sake tsara fossil taxa da dama zuwa species biyu na **Nanaimoteuthis**, da aka interpret a nan a matsayin early finned octopuses. Fossils sun tura record na finned octopuses zuwa kusan **shekaru miliyan 100 da suka wuce**. Daga jaw-size scaling, marubutan sun kiyasta total lengths kusan **2.8–7.7 m** ga **N. jeletzkyi** da **6.6–18.6 m** ga **N. haggarti**. Heavy jaw wear — chips, scratches, polish, cracks, da asymmetric edge loss — yana nuna repeated hard-prey crushing da possibly lateralized behavior. Gigantic estimated size plus durophagous carnivory suna goyon bayan interpretation cewa waɗannan octopuses watakila sun kasance a top tier na marine food webs. shaida ba ya haɗa whole bodies, exact lengths, identified prey, ko direct measurements na intelligence. Authored research article ba ya propose predation a large marine reptiles.

Binciken No-BS

Abin da takardar ta nuna: Large Cretaceous octopus-line jaws, revised a matsayin *Nanaimoteuthis* species biyu da placed within finned octopuses; older record ga Cirrata; body-size estimates da suka kai several meters kuma possibly har 18.6 m; extensive adult jaw wear consistent with hard-prey feeding; asymmetric wear consistent with mai yiwuwa lateralized behavior.

Abin da yake yiwuwa amma ba a tabbatar ba: Cewa *N. haggarti* yana cikin largest invertebrates ever known; cewa dabbobin sun kasance true top predators; cewa asymmetric wear yana reflect behavioral lateralization da advanced cognition.

Abin da ba ya nuna: Whole-body fossils; direct prey ko stomach contents; exact body lengths; predation on large marine reptiles; direct shaida na intelligence; cewa duk early octopuses giants ne.

Babban limitations: Body size inference ne ta multi-step jaw-to-mantle-to-total-length scaling model; top-predator status inference ne daga estimated size plus durophagous carnivory; behavior inference ne daga asymmetric wear; fossils jaws ne maimakon whole animals ko direct prey.

Nawa ne amincewar da mai karatu na gama gari ya kamata ya yi? Mai girma cewa fossils ɗin suna haɗa very large early finned-octopus jaws tare da strong wear shaida. Matsakaici cewa largest animals sun kai upper end na 6.6–18.6 m estimate. Matsakaici cewa true top predators ne maimakon very large hard-prey carnivores. Kasa cewa za mu iya faɗin abu specific game da intelligence ɗinsu. Matsayin da ya dace: spectacular fossil story, amma wanda aka gina daga jaws da inference, ba complete sea monster ba.

Sabuntawa bayan wallafawa**• Gyara · 2026-07-26**

Bayan feedback daga corresponding author Yasuhiro Iba, mun bayyana a fili cewa authored research article yana amfani da large marine reptiles a matsayin comparisons maimakon prey, kuma mun fayyace bambanci tsakanin authored research article da separate Editor's Summary na Science kan prey attribution. Mun kuma faɗaɗa digital fossil-mining method da top-predator evidence, kuma muka duba complete supplementary package.

Majiyoyi

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<https://doi.org/10.1126/science.aea6285>

Supplementary methods, text, figures S1–S6, and references

https://www.science.org/doi/suppl/10.1126/science.aea6285/suppl_file/science.aea6285_sm.pdf

Supplementary tables S1–S6

https://www.science.org/doi/suppl/10.1126/science.aea6285/suppl_file/science.aea6285_tables_s1_to_s6.zip

MDAR reproducibility checklist

https://www.science.org/doi/suppl/10.1126/science.aea6285/suppl_file/science.aea6285_mdar_reproducibility_checklist.pdf

Fossil lower jaws dataset — Figshare

<https://doi.org/10.6084/m9.figshare.27933759>

Tomographic animations — Figshare

<https://doi.org/10.6084/m9.figshare.27935904>

CPU-enabled AI segmentation code — Zenodo

<https://doi.org/10.5281/zenodo.15176344>