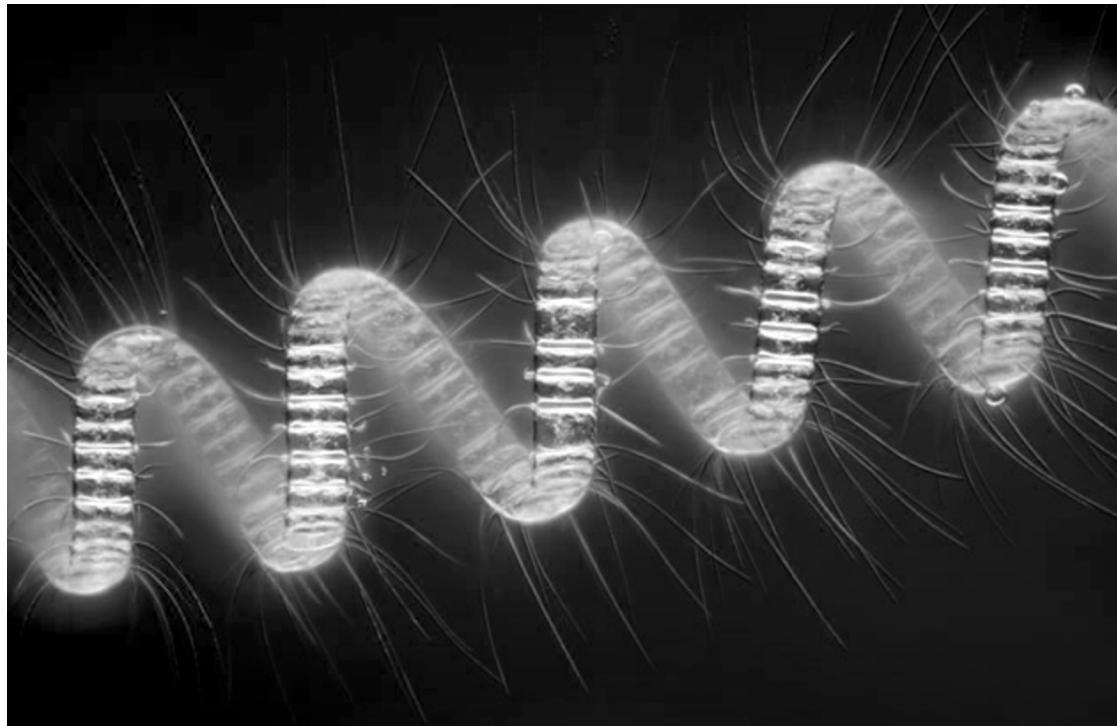


```
(*© 2012-Present Dara O shayda, Creative Commons License *)
(*https://creativecommons.org/licenses/ : Attribution-NonCommercial-ShareAlike *)
```

```
SetOptions[EvaluationNotebook[], Background → LightGray]
```

```
In[®]:= img = ;
```

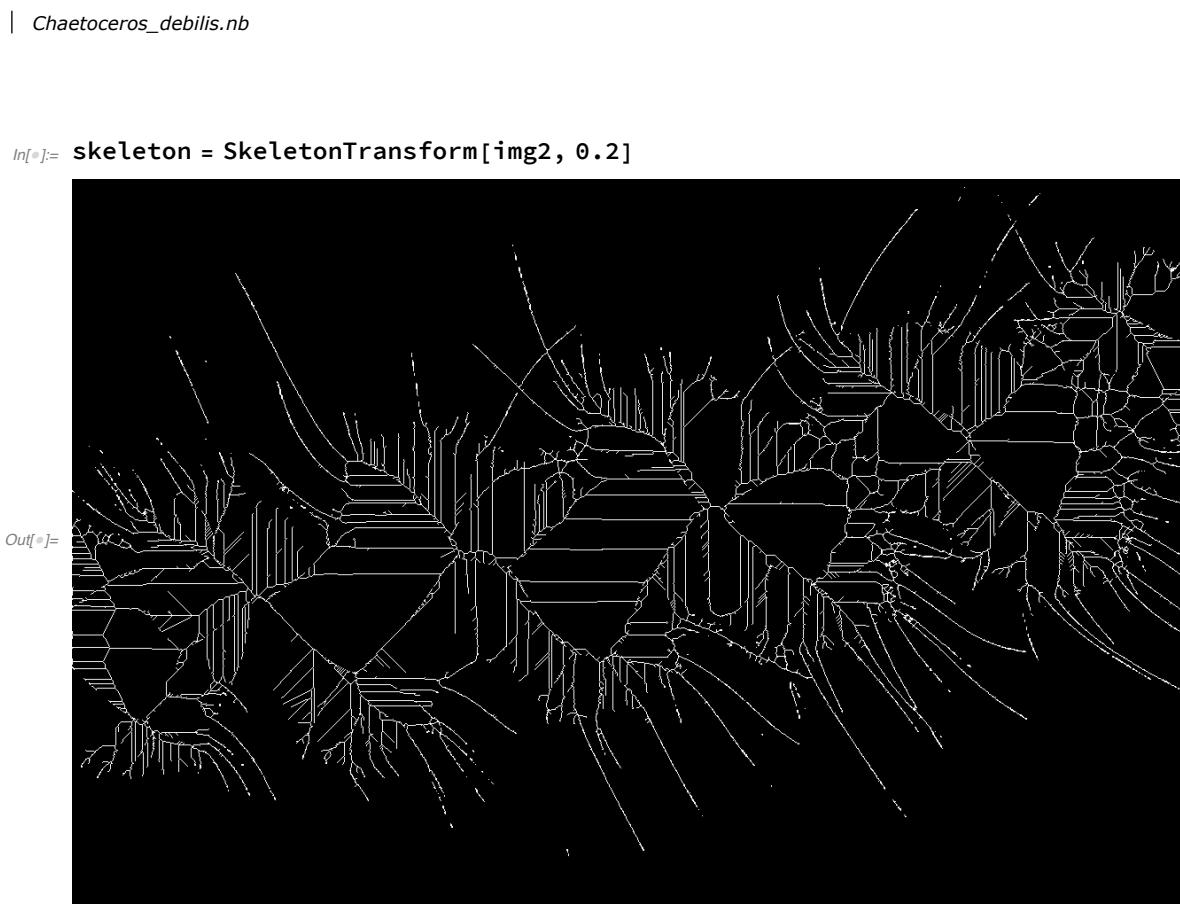
```
img2 = ColorSeparate[img][[1]]
ImageDimensions@img2
```



```
Out[®]=
```

```
{1254, 818}
```

```
In[1]:= skeleton = SkeletonTransform[img2, 0.2]
```



```
In[2]:= skeleton2 = Binarize@ImageResize[skeleton, {30 * 60, Length@notes}]
```



```
In[®]:= min = Min@ImageData[skeleton2]
max = Max@ImageData[skeleton2]
img3 = Rescale[(ImageData[skeleton2]), {min, max}];
dt = 0.05; (*duration of each vertical scan line*)
damp = 2; (* max duration of a note*)
strum = 0.1;
scannotes = Table[
(*test img3={{0,1,1,1,0,1,0,1,1,0,0,0,0,1,0,1,1,1,0,0},
{0,1,1,1,0,1,0,1,1,0,0,0,0,1,0,1,1,1,0,0}};*)
scan = Join[{0}, img3[[i]], {0}];
(*join the notes into longer intervals to avoid unnecessary gated-ness*)
intr = Flatten@Table[If[(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] ≠ 0) ||
(scan[[j]] ≠ 0 && scan[[j - 1]] != 0 && scan[[j + 1]] == 0) ||
(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] == 0),
If[(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] == 0), {j, j}, j],
Nothing], {j, 2, Length@scan}] - 1;

(*Sound the notes with proper duration*)
Table[SoundNote[assoc[i], If[Norm[{intr[[j]], intr[[j + 1]] + 1} * dt] < damp,
{intr[[j]], intr[[j + 1]] + 1} * dt + {strum*(i), strum*(i)},
{intr[[j]] * dt, intr[[j]] * dt + damp} + {strum*(i), strum*(i)}],
"Piano"], {j, 1, Length@intr - 1}],
{i, 8, (Dimensions@img3)[[1]] - 8}];
```

Out[®]= 0

Out[®]= 1

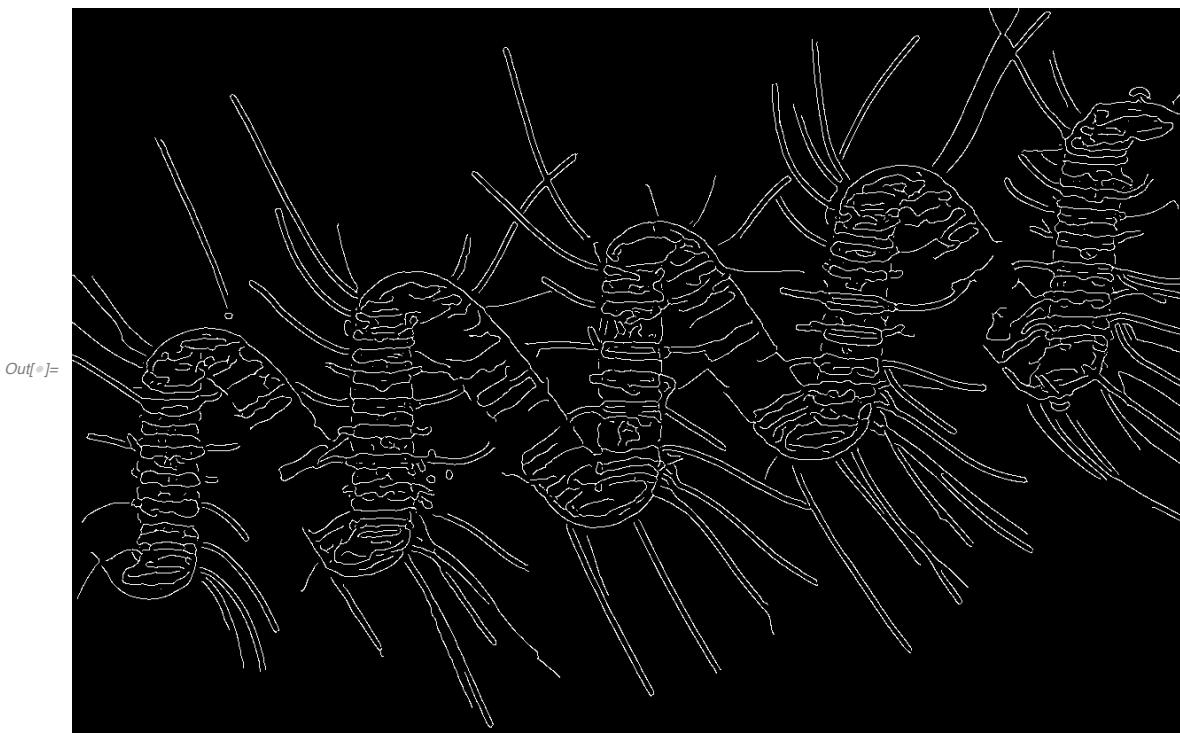
In[®]:= Sound@Flatten@scannotes

The image shows a Mathematica notebook interface. At the top, there is a grayscale image of a Chaetoceros skeleton pattern. Below the image is a playback control bar with a play button, a stop button, and a timer indicating "94.55 s".

```
In[®]:= Export[FileNameJoin[{NotebookDirectory[], "Chaetoceros_debilis_skeleton.mid"}],
Sound@Flatten@scannotes]
```

Out[®]= /Users/darashayda1xfer/Documents/Sufi Notes/Chaetoceros_debilis_skeleton.mid

```
In[4]:= edge = EdgeDetect[img, 6]
```



```
In[5]:=
```

```
edge2 = Binarize@Thinning@ImageResize[edge, {30 * 60, Length@notes}]
```

Out[5]=



```
In[®]:= min = Min@ImageData[edge2]
max = Max@ImageData[edge2]
img3 = Rescale[(ImageData[edge2]), {min, max}];
dt = 0.05; (*duration of each vertical scan line*)
damp = 2; (* max duration of a note*)
strum = 0.1;
scannotes = Table[
(*test img3={{0,1,1,1,0,1,0,1,1,0,0,0,0,1,0,1,1,1,0,0},
{0,1,1,1,0,1,0,1,1,0,0,0,0,1,0,1,1,1,0,0}};*)
scan = Join[{0}, img3[[i]], {0}];
(*join the notes into longer intervals to avoid unnecessary gated-ness*)
intr = Flatten@Table[If[(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] ≠ 0) ||
(scan[[j]] ≠ 0 && scan[[j - 1]] != 0 && scan[[j + 1]] == 0) ||
(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] == 0),
If[(scan[[j]] ≠ 0 && scan[[j - 1]] == 0 && scan[[j + 1]] == 0), {j, j}, j],
Nothing], {j, 2, Length@scan}] - 1;

(*Sound the notes with proper duration*)
Table[SoundNote[assoc[i], If[Norm[{intr[[j]], intr[[j + 1]] + 1} * dt] < damp,
{intr[[j]], intr[[j + 1]] + 1} * dt + {strum*(i), strum*(i)},
{intr[[j]] * dt, intr[[j]] * dt + damp} + {strum*(i), strum*(i)}],
"Piano"], {j, 1, Length@intr - 1}],
{i, 8, (Dimensions@img3)[[1]] - 8}];
```

Out[®]= 0

Out[®]= 1

In[®]:= Sound@Flatten@scannotes



In[®]:= Export[FileNameJoin[{NotebookDirectory[], "Chaetoceros_debilis_edge.mid"}],
Sound@Flatten@scannotes]

Out[®]= /Users/darashayda1xfer/Documents/Sufi Notes/Chaetoceros_debilis_edge.mid

Piano 88 Keyboard

Frequency (Hz) Scientific Note #

27.500	A0	
30.868	B0	
32.703	C1	
36.708	D1	
41.203	E1	
43.654	F1	
48.999	G1	
55.000	A1	
61.735	B1	
65.406	C2	
73.416	D2	
82.407	E2	
87.307	F2	
97.999	G2	
110.00	A2	
123.47	B2	
130.81	C3	
146.83	D3	
164.81	E3	
174.61	F3	
196.00	G3	
220.00	A3	
246.94	B3	
261.63	C4	
293.67	D4	
329.63	E4	
349.23	F4	
392.00	G4	
440.00	A4	
493.88	B4	
523.25	C5	
587.33	D5	
659.26	E5	
698.46	F5	
783.99	G5	
880.00	A5	
987.77	B5	
1046.50	C6	
1174.66	D6	
1318.51	E6	
1396.91	F6	
1567.98	G6	
1760.00	A6	
1975.53	B6	
2093.00	C7	
2349.32	D7	
2637.02	E7	
2793.83	F7	
3135.96	G7	
3520.00	A7	
3951.07	B7	
4186.01	C8	

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Here is a list consisting of the frequencies in a one-octave, equal-tempered chromatic scale starting at 440 Hertz.

```
In[®]:= freq = Table[N[440 × 2i/12], {i, -4 * 12, 3 * 12 + 3}]
Out[®]= {27.5, 29.1352, 30.8677, 32.7032, 34.6478, 36.7081, 38.8909, 41.2034, 43.6535,
46.2493, 48.9994, 51.9131, 55., 58.2705, 61.7354, 65.4064, 69.2957, 73.4162,
77.7817, 82.4069, 87.3071, 92.4986, 97.9989, 103.826, 110., 116.541, 123.471,
130.813, 138.591, 146.832, 155.563, 164.814, 174.614, 184.997, 195.998,
207.652, 220., 233.082, 246.942, 261.626, 277.183, 293.665, 311.127, 329.628,
349.228, 369.994, 391.995, 415.305, 440., 466.164, 493.883, 523.251, 554.365,
587.33, 622.254, 659.255, 698.456, 739.989, 783.991, 830.609, 880., 932.328,
987.767, 1046.5, 1108.73, 1174.66, 1244.51, 1318.51, 1396.91, 1479.98,
1567.98, 1661.22, 1760., 1864.66, 1975.53, 2093., 2217.46, 2349.32, 2489.02,
2637.02, 2793.83, 2959.96, 3135.96, 3322.44, 3520., 3729.31, 3951.07, 4186.01}
```

Corresponding list of notes:

```
In[®]:= notes = Join[{"A" <> ToString[0], "A#" <> ToString[0], "B" <> ToString[0]},
Flatten@Table[{"C" <> ToString[i], "C#" <> ToString[i], "D" <> ToString[i],
"D#" <> ToString[i], "E" <> ToString[i], "F" <> ToString[i], "F#" <> ToString[i],
"G" <> ToString[i], "G#" <> ToString[i], "A" <> ToString[i],
"A#" <> ToString[i], "B" <> ToString[i]}, {i, 1, 7}], {"C" <> ToString[8]}]
Out[®]= {A0, A#0, B0, C1, C#1, D1, D#1, E1, F1, F#1, G1, G#1, A1, A#1, B1, C2, C#2,
D2, D#2, E2, F2, F#2, G2, G#2, A2, A#2, B2, C3, C#3, D3, D#3, E3, F3, F#3,
G3, G#3, A3, A#3, B3, C4, C#4, D4, D#4, E4, F4, F#4, G4, G#4, A4, A#4, B4, C5,
C#5, D5, D#5, E5, F5, F#5, G5, G#5, A5, A#5, B5, C6, C#6, D6, D#6, E6, F6, F#6,
G6, G#6, A6, A#6, B6, C7, C#7, D7, D#7, E7, F7, F#7, G7, G#7, A7, A#7, B7, C8}
```

Length@notes

Length@freq

88

88

Associate the notes the frequencies and key number:

```
In[®]:= assoc = <|
0 → 0,
Sequence @@ Flatten@Table[{freq[[i]] → notes[[i]],
notes[[i]] → freq[[i]]}, i → notes[[i]]], {i, 1, Length@notes}]|>;
```